MAR 6 1928

AW-HILL PUBLISHING COMPANY, INC. MARCH 3, 1928 TWENTY-FIVE CENTS PER COPY

ENGINEERING AND MINING JOURNAL

METAL AND NON-METALLIC MINING · MILLING · SMELTING · REFINING · MARKETING

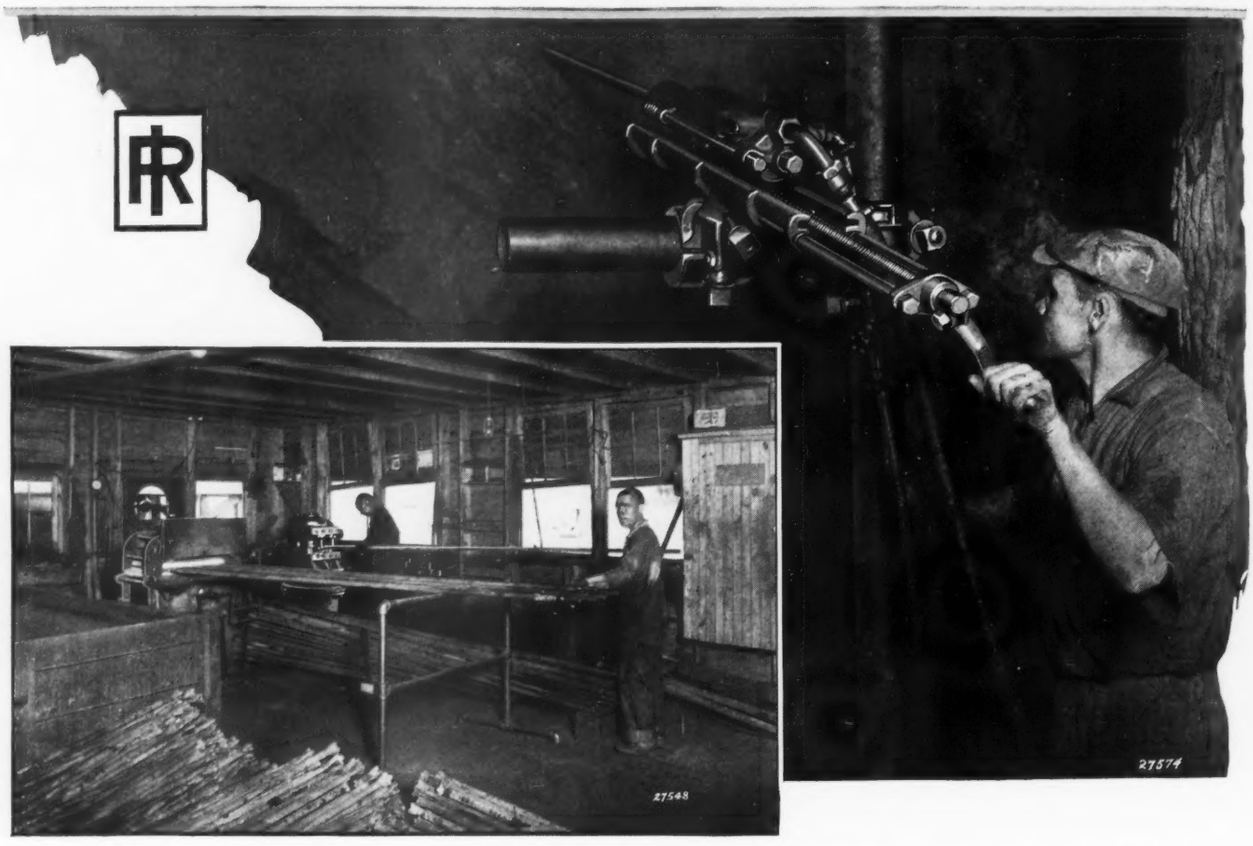
C. A. Mitke begins another series of articles on mining practice—*In this issue:* Caving Methods in General

Utah Copper Company's new residence settlement at Bingham Canyon. A Model Home Town, by Wm. Spencer

Résumé of field evidence concerning Leached Outcrops of Ore—Part Two, by Roland Blanchard and P. F. Boswell

Two Pages of Useful Operating Ideas . . . Complete Price Quotations on Metals and Non-Metallic Minerals

The New Musconetcong Tunnel



I-R Drills Selected in 1872 and again in 1927

Fifty-seven years ago, when the Ingersoll Drill Company was only in the second year of its existence, Ingersoll machines were selected for driving the Musconetcong Tunnel. The tunnel was 4829 ft. long, 21 ft. high, and 26 ft. wide; it was considered a great engineering achievement, as the job marked the acceptance of mechanized tunnel methods.

Now again, when a second tunnel is being driven through the Musconetcong Mountains, parallel to and only a few rods from the old job, I-R Drills are once more doing the work. I-R Drill Steel, Oil Furnaces, Sharpeners, Hoists, and Accessories are also helping to speed the job.

The selection of I-R machines is a testimonial to Ingersoll-Rand quality; for in 1872, as well as today, the selection of drills, steel, etc., depended upon three all-important points—durability, economy, and efficiency.

To build and hold a reputation for fifty-seven years is an achievement of which any company can rightfully be proud.

(The new Musconetcong tunnel is being built for the Lehigh Valley R.R. by Bates & Rogers Construction Co., Chicago, Ill.)

INGERSOLL-RAND COMPANY . 11 Broadway . New York City

Offices in principal cities the world over

For Canada Refer—Canadian Ingersoll-Rand Co., Limited, 10 Phillips Square, Montreal, Quebec

164-LI

Ingersoll-Rand

ENGINEERING AND
MINING JOURNAL

McGraw-Hill Publishing Company, Inc.
JAMES H. MCGRAW, *President*

A. W. ALLEN,
Editor

VOLUME 125 — *New York, March 3, 1928* — NUMBER 9

Can the Buyer Overplay His Present Market Advantage?

INDUSTRY AND BUSINESS for more than a year have been experiencing a buyers' market: the equipped capacity for the production of raw materials and of finished manufactured products, generally speaking, has been greater than the demand. As a consequence, competition for orders has been tremendous; buyers have been in a position where they could "play" sellers against each other, thus obtaining commodities at prices more and more closely approaching the actual cost of production. This has tended to develop the condition aptly called "profitless prosperity." Production and sales have been large, but the unit margin of profit has been so small that, on the basis of capital invested, earnings have been disproportionately low.

Only a few years ago the opposite situation obtained; production was limited, demand was keen, and buyers were compelled to bid against each other to get needed material, machinery, and other supplies. Prices and profits climbed; producers and manufacturers sat back and waxed fat. Now the shoe is on the other foot, and producers are in a grave predicament. The question may fairly be asked: Can the buyer press this advantage too far—to such an extent, that the result in the long run will prove disastrous to the buyer himself?

One vital difference may be pointed out between a market that distinctly favors the seller and one that distinctly favors the buyer. Whereas each successive buyer is able to pass on the high cost until it is finally paid by the ultimate consumer, when the situation is reversed the embarrassed seller—at least with respect to the producer of raw materials—has no such recourse to assure himself a profit. If the condition persists long enough he is obliged to suspend operations and eventually is forced into bankruptcy.

But, before catastrophe befalls, he is in a predicament that operates to the disadvantage of his customers. If a buyer takes a broad view of the situation, he will realize that any transaction in which the seller incurs a loss or fails to make a reasonable profit is economically unsound. The unavoidable consequence of conducting business on this basis is that research is stifled; improvement in plant and equipment is neglected; and progress in production, manufacture, and distribution methods is halted. It should not be forgotten that it is to the advances made in this direction that industry owes the remarkable reduction in recent years in the cost of most of what it required.

It is significant that, in recent weeks, the responsible executives of two big companies that are among the largest users of a certain important non-ferrous metal independently and frankly expressed the hope that producers will be able to avoid further reductions in price. It is significant that an official of one of the most important companies consuming another non-ferrous metal says that he would be willing to pay one cent more than the current price, *if* he could be sure that his competitors were paying the same price, and could feel reasonably sure that a precipitous drop might not take place in a month.

These consumers reason that a healthy economic status for the mining industry will in the long run benefit their own companies as buyers. They count the reasonable assurance of an adequate future supply of metal at a fair price as more to be desired than a slightly lower price at the moment, with the probability of disruption of the mining industry and a consequent rapid advance of prices. Wide and erratic fluctuations in commodity prices are of value only to the speculative trader. Far-seeing buyers should know that the practice of pressing a temporary advantage as far as they can will ultimately prove a boomerang.

Developments in the Metallurgy of Zinc—The Coley Process

IN THE January bulletin of the Institution of Mining and Metallurgy, Mr. H. Edwin Coley describes a process for the extraction of zinc and other metals from ores, embodying principles of great interest to metallurgists and forecasting the possibility of fundamental changes in metallurgy. The reduction of metallic oxides has been the objective of much research. Mr. Coley relies on the cracking of hydrocarbons in contact with heated ore to produce nascent carbon, with simultaneous reduction of the oxides in the ore. A necessary condition is to maintain the hydrocarbon in a cold state until it comes in contact with the ore.

Much difficulty was experienced in developing mechanical appliances for the heating, reduction, and removal of volatile products, but Mr. Coley's description leaves one very much in the dark as to details. He states that zinc ore (nature not given) is crushed to pass a ¼-mesh screen and fed to a preheater, where its temperature is raised to that required for reduction. From there it passes through a worm feed, which forms its own seal, into a revolving tube of "cronite" or other alloy, through which it passes slowly at the temperature required for reduction, stated to be 300 to 350 deg. C. lower than that required in zinc retorting. Extraction is "as high as 97.3 per cent." The tube used (18 in. diameter by 30 ft. in length) is also stated to be equivalent in capacity to a zinc furnace carrying 200 medium-sized retorts. The temperature required for reduction of the zinc ore is stated to be 1,050 to 1,100 deg. C., and the time required for the operation ranges from two and a half to three

and a half hours. The difficulties involved in the removal and condensation of the fume have been overcome, according to the account.

Considering essentials only, the process consists in subjecting a slowly moving mass of ore particles, heated to a suitable temperature in an inert atmosphere, to a hydrocarbon which, under the temperature conditions prevailing, breaks down and supplies a strong reducing agent that converts oxides.

Zinc metallurgists have persistently sought to perfect a process to supplant the zinc-retort method. They have been successful in establishing a hydrometallurgical process on a commercial basis, but the application is restricted to places where comparatively cheap and abundant electric power is available. Under present conditions the zinc hydrometallurgical plant is as important a factor for the consumption of electrical energy as it is for the recovery of zinc from its ores.

Electrolytic zinc, the production of which has steadily increased, is an important competitor with retort zinc. However, the retort plant continues to be a vital factor, although its use is restricted to places where relatively cheap fuel is available close to zinc-ore and finished-product markets. Development of the Coley process has been slow, and its sponsors have been secretive; but if it is successful in commercial trials it will become important in the zinc metallurgical field, with promise of influencing iron-ore metallurgy also.

Aviation and the Mining Industries

APPARENTLY the use of the airplane in the mining industries, for the transport of men and supplies and valuable mine products, is growing daily. A new freight and passenger airplane company recently placed orders for twenty machines to be used in the Flin Flon district of northern Manitoba. Although a railroad branch line into the district is under construction, it is pointed out that, even when the trains are operating, scores of planes will have to be utilized to connect remote points in the mining region, where roads will not be ready for many years.

The chairman of Crown Mines, Ltd., according to a recent interview, considers that the aërial transport of gold produced on the Witwatersrand would be practicable and desirable in the near future. "The transportation of gold by air," he added, "possesses many advantages over surface methods. In Europe today almost all the gold is transported by air in preference to railways and steamers. It is simpler, quicker, cheaper, less risky, and more effective generally." Aërial transportation of cut and uncut diamonds between London and Amsterdam has been the practice for many years.

Several weeks ago a prospector from northern Manitoba called. The conversation turned to the problem of transport in that region. "Last year I used dogs," he said, "but this year I'm going to mush it alone. Dogs tie you down. In summer months, when I'm traveling by canoe to and from my claims, it is expensive having some Indian keep the dogs, especially as several usually die under such care. What I really need is a small seaplane. I have to travel 200 miles by canoe to reach a claim that is but one-half hour's airplane travel from my cabin."

The Standard Oil Company of California recently placed an order for a tri-motored airplane to carry eight or ten passengers, to be used for visiting airports on the Pacific Coast and so arousing interest in aviation, and also for the experimental study of airplane fuels and lubricants. Incidentally, company officials are to be transported thus on business trips. At least one other mining company in California, in Mono County, is operating an airplane. This method of transportation will undoubtedly find many applications in the mining industries, especially as a solution for unusual problems.

Geophysical Prospecting and the Critic

A TENDENCY to judge too quickly of the value of geophysical prospecting is evident at times in various quarters. The critics displaying this tendency seem unaware of the already widely accepted view that geophysical work is at least a valuable aid to the geologist. Technical magazines throughout the world are generous in the amount of space allotted to the subject. Likewise the technical societies feature it in the programs of their meetings. Despite this, every so often some individual announces critically that in such and such an area a large sum of money has been spent on geophysical work without discovery of an important orebody. In at least one of these instances the statement made was incorrect. In general, it would be fairer and possibly wiser to withhold such criticism. Everyone should realize that considerable time is required to check the results of a geophysical survey, bearing in mind also that the barren diamond-drill core is not always conclusive evidence.

Further, because a certain geophysical method may have given unsatisfactory results when checked against a known occurrence it does not follow that geophysical methods in general are thereby discredited or, indeed, even the particular method that failed. Employment of different methods on a single area is advocated, if conditions warrant. The total cost of such work will be considerably less than that of random drifting and crosscutting underground, based on hunches, "mining sense," and guesses.

Molybdenum: An American Metal for Alloy Steel

THE United States has not been generously endowed by Nature with most of the semi-rare metallic minerals from which steel-alloying materials are derived. These materials include ores of tungsten, chromium, manganese, nickel, vanadium, and molybdenum, and to some extent, titanium and zirconium. Almost all the chromium and nickel used is imported, the chromium coming from Africa and the nickel from Canada. By far the largest proportion of the tungsten, manganese, and vanadium used is also imported, though the domestic production is not insignificant and may be capable of development. Of molybdenum, however, an almost unlimited supply is available, comparable to the resources of nickel in Ontario; so it would seem the part of wisdom for American users of steel to give as much encouragement as possible to its industrial use. Thus can American independence in the matter of alloy steels be furthered in case of war, and a domestic and easily accessible source of supply at

a reasonable price to all manufacturers be assured at all times.

Of the steel produced in the United States, only about 5 per cent is designated as alloy steel. Its advantages are chiefly recognized by the automobile industry, which takes over two-thirds of the total. The various metals enumerated above have somewhat similar effects, in general improving the structure of the steel, making it harder, tougher, and of a superior quality for most of the various purposes for which it is used. More than one alloying element is often added; molybdenum, for example, frequently being used with chromium or nickel, or both, depending on the qualities that are desired in the product.

ALLOY-STEEL manufacturers in general have the problem of weaning consumers from straight carbon steel; those particularly interested in molybdenum have to prove, in addition, that steels containing molybdenum are better or cheaper than those of different alloy composition. Though the attack has been centered on the automobile industry, with excellent results, other outlets of importance have also been found. For instance, the advantages of molybdenum steel have been developed for the benefit of manufacturers of roller and anti-friction bearings, tools, die blocks and dies, rolling-mill rolls, gears and pinions, and similar materials. Many mine shovels are made of molybdenum steel.

Under existing industrial conditions a comparatively small proportion of the molybdenum output—perhaps 5 per cent—finds its way into industry in the metallic form as oxide, being used in the electrical industry, for chemical reagents, and as a mordant in dye work. Enlargement of these at present modest demands is worthy of attention. All told, the consumption of molybdenum in finished products in the United States in 1927 was probably between 900,000 and 1,200,000 lb., with the foreign consumption amounting to about 70 per cent of that in the United States.

AS TO molybdenum resources, the world has one outstanding mine—that of the principal producer, the Climax Molybdenum Company, at Climax, near Leadville, Colo. About twenty-five million tons of low-grade ore containing about 0.9 per cent of molybdenite (MoS_2), is estimated to exist in this deposit, or enough to supply the world, at its present rate of consumption, for two hundred years. This company is controlled by interests closely identified with the control of the American Metal Company. Another company, the Molybdenum Corporation of America, has been a smaller producer, and has three promising properties of considerably less proved extent, though of higher grade. One near Questa, N. M., has been in operation for six years; it is a vein deposit, the ore from which, as milled, contains about 7 per cent MoS_2. Here, geophysical prospecting recently conducted has been productive of interesting results.

The Leviathan mine, at Yucca, Ariz., a war-time producer, is also being operated, and a third property of good possibilities, now under development, the Andy-Star claims, near Loomis, Wash., was recently purchased. Many other deposits are also known in the United States; but, in general, they are too limited in extent or too far from transportation to warrant commercial production under present conditions, although many are reported to have high-grade ore. Most of the Arizona occurrences contain appreciable amounts of copper associated with the molybdenum, which must be removed by selective flotation.

With the present operations of the molybdenum industry centered in two companies, each of which has its own properties, it can well be recognized that the market for ore or concentrates is only nominal, and the opportunity for selling undeveloped prospects is also decidedly limited. An occasional carload of concentrates might be marketed at from 25 to 45c. per pound of contained MoS_2 for 80 to 85 per cent concentrates, and there is also a market abroad.

As to other countries, some production has been made from Norway, in amount equal to perhaps 10 per cent of that produced in the United States, but it is understood that the output there is declining. Australia and Canada, quondam producers, are of comparatively no importance as factors in the industry. The predominance of the United States in molybdenum production is indicated by the fact that about 40 per cent of the domestic production is exported.

TECHNICALLY, much progress has been made in molybdenum production. The metal occurs as molybdenite; in comparison, wulfenite, a lead molybdate, is of little economic value. Molybdenite is somewhat similar to graphite, occurring in flexible scales or grains, having a greasy feel, and being soft enough to mark paper. It is easily concentrated by flotation, to about 80 per cent MoS_2, from which it can be converted to a compound desirable for steel making without great expense. Formerly almost all the concentrate was reduced to ferromolybdenum, containing from 50 to 85 per cent iron. In 1924, however, molybdenum in an oxide form was introduced and found acceptable, and as this cost less it came into wide use. Some users prefer ferromolybdenum, but the oxide is the usual market form. The Climax company, at its Langeloth, Pa., plant, manufactures this as calcium molybdate by sintering the roasted ore with lime. The Molybdenum Corporation product of a similar nature is called Molyte, and is made by fusing the roasted concentrate in an electric furnace with lime, silica, fluorspar, and a little carbon, the work being carried on at the Washington, Pa., plant of the company, where ferromolybdenum is also made. Even a brief reference to the metallurgy of molybdenum would be incomplete without mentioning the pioneer work of Mr. C. Harold Wills in developing molybdenum alloy steels.

APPLICATION of improved technical methods has resulted in a steady decline in selling price. In 1918 this was $5 per pound of contained molybdenum, as used by the steel makers. Three to five years ago it had dropped to $2; then, in 1925, to $1.25; and now, at the beginning of 1928, it is listed at 95c. The consumption of molybdenum has increased as prices have come down, until now it is used in the manufacture of over 250,000 tons of iron and steel per annum, usually to the extent of about 0.04 per cent in steel, and 0.1 per cent or less in iron. At the new low prices, molybdenum steel can be sold for about $1.50 per ton less than chrome-nickel steel. With reasonable prices and an assured domestic supply, steel users in the United States may well give more attention to this product.

*Caving Methods in General**

By CHARLES A. MITKE
Consulting Mining Engineer, Phoenix, Ariz.

Synopsis—Ore production by the caving methods is effected by forced caving. This is accomplished by undercutting a block of ore and carrying up boundary shrinkage stopes on three and possibly four sides, which removes the support from beneath and around the block to be caved. The block then settles, cracking up and partly disintegrating in the process. Later mining consists mainly in drawing-off operations beneath, under control.

SUCCESS with caving methods of mining has been attained largely by working in accord with natural laws. It has been demonstrated in practice that caving and subsidence are natural consequences of mining. Extraction of a certain volume of ore beneath a block of ground, at any depth, removes its immediate support, and, if the area mined is extensive enough (unless some definite means of support is provided in place of the extracted ore), the block will settle, and caving and subsidence ensue. As the ground mass settles, breaking and crushing of the rock take place through natural caving, so that far less drilling and blasting are required than when all mining is conducted in solid ore, unaided by nature.

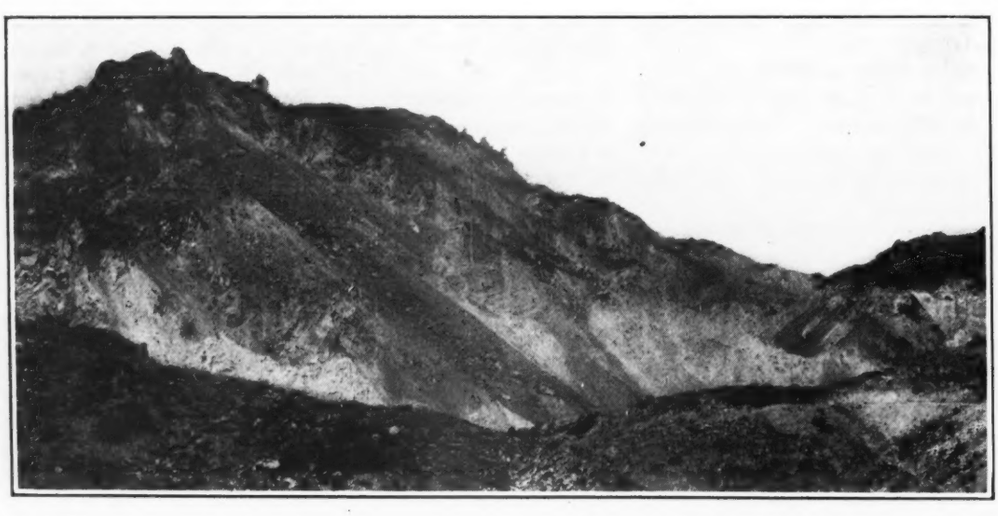


Fig. 1—Subsidence of surface over ground that is being worked by a branch-raise mining system, Inspiration-Miami district, Arizona

Several distinct classes of caving methods may be noted, each having a number of modifications. These are the following: (1) The branch raise; (2) combined shrinkage and caving; (3) sublevel caving; and (4) top-slicing.

The three major operations involved in the first class, and generally in the second and third of the above-noted classes, are:

(*a*) The natural supports are removed from beneath a given block of ground; or, technically speaking, "the block is undercut."

(*b*) The block having been undercut, settling and caving ensue, and nature assists in breaking up and crushing the mass, thus preparing it for transfer to the ore cars. In other words, during the process of settling or caving, the block of ore cracks up and partly disintegrates.

(*c*) The principles of gravity are applied to ore flowage, by locating a multiplicity of small avenues, technically known as "finger raises," at regular intervals beneath the crushed mass, all of which lead into main arteries, whence the ore runs into motor cars. This is essentially the "drawing operation."

Approximately 5 to 10 per cent of the ore is broken by drilling from the "undercutting level"; the remainder cracks up into large boulders and masses, and partly disintegrates as "drawing off" progresses. The daily drilling and blasting, first, in the drawing-off chutes from the finger raises, and, second, on the grizzly level, have for their objectives the breaking of these boulders, to maintain continuous ore flowage into storage chutes, whence ore is drawn into cars.

In the fourth class of caving methods noted—namely, top-slicing—the three operations are somewhat modified. If the stopes are carried on the incline,[1] the ore must be drilled and blasted (as in any mining operation conducted in solid ore), and then timber supports, resembling square sets, erected. When this is done, operation *c*, which is the application of the principles of gravity to ore flowage, comes into play, and the ore runs to central chutes, from which it is drawn into cars. When all ore has been extracted from the stope, the timber supports are blasted down (operation *a*), and the overburden and timbered mat settle and cave (operation *b*). Of course, when

*This is the seventh of the series by Mr. Mitke in which he outlines modern stoping methods.

[1] "Incline Top-slicing." Vol. 59, A.I.M.E. Page 305.

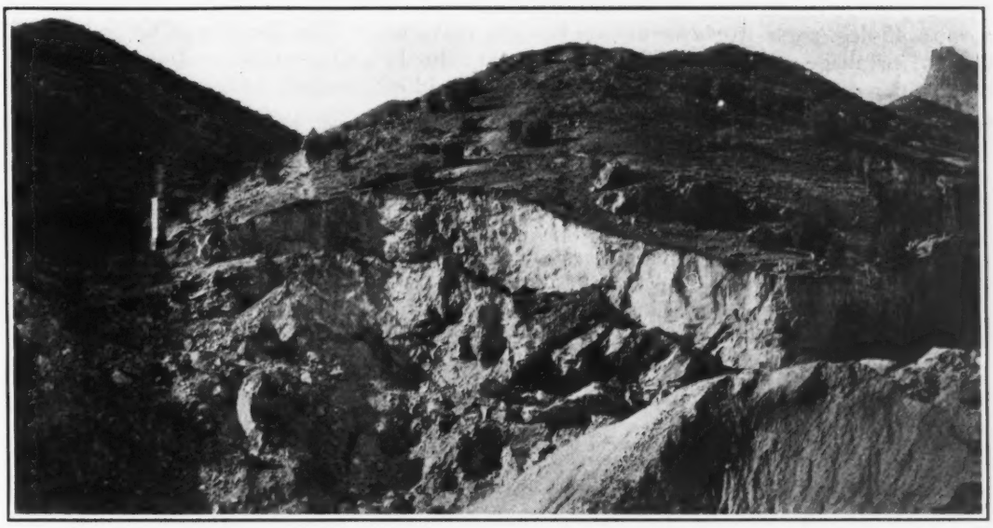


Fig. 2—Subsidence of surface over ground worked by combined shrinkage and caving method, Ray district, Arizona

top-slice stopes are carried on the horizontal, all ore must be transported, either by hand or scrapers, and operations *a* and *b* are the only rules that apply.

In this paper, the term "block caving" has not been applied to any particular variation of caving, for the reason that all caving is really block caving regardless of the size and shape of the block caved. The term is, therefore, too general to be applied to any subdivision.

The branch-raise system, with its main trunk arteries, (or haulage chutes), dividing into smaller raises which again branch into finger raises, resembles the skeleton of a tree; hence the term. Mining by the branch raise and combined shrinkage and caving methods, consists, mainly, in drawing off the ore.

The process of caving a body of ore involves, first, "undercutting the ore by drilling and blasting"; second, "the settling and caving of the block thus undercut"; and, third, "drawing off the ore evenly beneath, through chutes, into cars." A repetition of these three operations, with a few minor variations in the details, forms the basis of all the branch-raise methods.

What actually takes place in mining a block of ground by this method is that the "drawing off" of the broken or crushed ore results in the formation of a cavity immediately beneath the solid material. The solid ore then breaks and caves to fill the cavity. The "drawing-off" operation is repeated, thus re-forming a cavity, which is again filled with broken ore, and so on until all the ore is extracted. However, in practice, the operations of "drawing off," "forming cavities," and "filling them with broken ore" follow one another with such rapidity that they merge and become one continuous drawing operation.

Surface Subsidence

Whenever a caving method is used, underground caving always occurs in the immediate vicinity of the block of ore mined, and if stoping operations are extensive this caving frequently results in surface subsidence, regardless of depth. The volume of surface subsidence is always less than that of the volume caved underground owing to the increased volume of the broken rock. At Miami, it was found that approximately 1 cu.ft. of volume of subsidence resulted from 1½ cu.ft. of excavation.[2] Cracks, resulting from the withdrawal of ore, and the corresponding subsidence, generally speaking, range between 60 and 70 deg., but cracks have been recorded with an angle as low as 40 deg. This, however, was due largely to faulting. J. Parke Channing states that "to be on the safe side in laying out a mining plant or other surface improvement (at a mine using caving or shrink-

[2]A.I.M.E. Vol. 69.

Fig. 3—Subsidence of surface over ground worked by top-slicing, Cananea district, Mexico

age), a 45-deg. angle would be assumed as the probable limit of breakage, and no surface improvements should be considered outside the danger zone if they lie within a plane or angle extending upward from the nearest

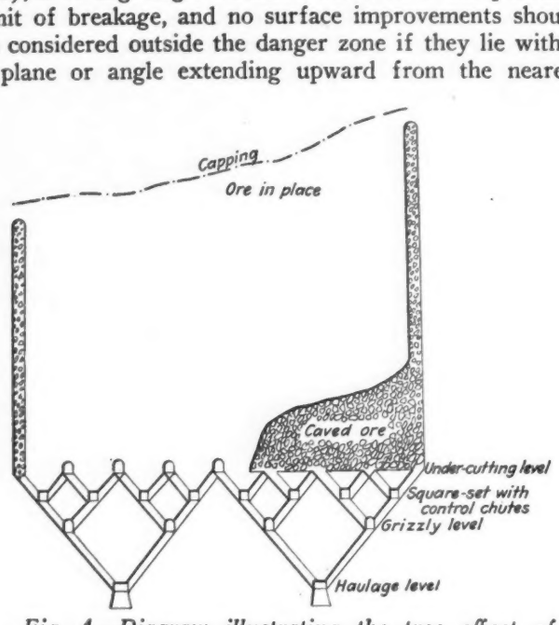


Fig. 4—Diagram illustrating the tree effect of branch-raise system, Inspiration, Arizona

boundary of the underlying ore at an angle of 45 deg. from the vertical."[3]

As previously mentioned, top-slicing is also a caving method, and surface subsidence may therefore be expected wherever it is used extensively.

When May Caving Methods Be Used?

Though known and applied, to a greater or lesser extent, for years, caving methods have had their greatest development and application during the era of exploitation of the porphyries, starting particularly with those low-grade deposits which of necessity called for the use of underground methods on a large scale, such as Inspiration, Ray, and Miami.

As previously said, nearly all stoping consists in breaking and removing rock from underground workings, and, as a natural consequence, more or less ground movement accompanies such operations. In some instances conditions are such that this movement is of no particular consequence; in others it is of the utmost importance.

Within certain natural limits, cavities in hard ground will generally stand open, with little or no resultant ground movement; cavities in medium ground are more susceptible to caving; cavities in soft ground give way and cave readily.

Dilution a Factor to Be Considered

Where surface subsidence may be permitted, the grade of the ore is frequently considered one of the determining factors in deciding whether stopes in medium and soft ground shall be supported and filled or allowed to cave. Supporting the back by means of waste fill necessarily adds to the stoping cost, but it prevents dilution of ore with waste and permits of more complete extraction. Eliminating filling and permitting the back to cave in the process of mining is a cheaper stoping method, but the percentage of ore extraction is not as high as with the filled methods.

[3]A.I.M.E. Vol. 69.

The location of an orebody also frequently determines whether a caved or filled method must be used. If an orebody is being stoped by a caving system, but is adjacent to another orebody that would come within the angle of caving of the first, the ore in the second orebody is likely to be broken and possibly lost.

If the orebodies are irregular, small, scattered, thin, or continuous, but pinch in places, caving is impracticable, as too much dilution would occur. If, on the contrary, the ore occurs in large and thick masses of a fairly uniform grade, and there is no objection to caving the surface, or underground, a caving method, or some combination of shrinkage and caving, is the ideal one to use.

Size of Operation an Important Factor

When a caving system is applied to a small orebody it may frequently prove to be far more costly per ton of ore extracted than when applied to large orebodies, because in a large orebody the expense of long and numerous raises, to allow the ore to run by gravity and thus eliminate shoveling, is justified by the large tonnage that will be drawn through them; whereas in a small orebody the total profit may not cover the cost of such expensive development.

Table I is illustrative of the various grades of ore now being mined by caving, shrinkage, and combination of both.

Table I—Grade of Ore Mined by Caving, Shrinkage

Company	Grade Per Cent Cu. High	Low	Avg.	Tons per Man	Total Mining Costs Per Ton	Remarks
Morenci (Phelps Dodge)	2.5	1.5	2.22 (*a*)	7.6 (All men in mine) 18.9 (Men on ore only)	.....	Sept., 1925 (includes salaried men)
Braden (Kennecott)	....	....	2.20 (*b*)	.....	.....	.....
La Touche mine (Kennecott)	....	....	1.70 (*b*)	.....	0.74c. (*d*)	Exclusive of general mine development, amounting to approximately 5c.
Copper Queen (Phelps Dodge)	....	....	1.50 (est.)	.....	.....	East orebody
Andes Copper	....	....	1.50 (*b*)	.....	.....	.....
Nevada Con	1.52	.70	1.268 (*c*)	.....	0.1053c. per lb. Cu.	.....
Chino, Ray,	....	....	1.40 (est.)	.....	0.81c.	Inc.udes overhead, but excludes taxes, depreciation, and general mine development.
Ruth	....	....	1.64 (*c*)	.....	0.96c.	.....
Inspiration	1.26	.81	1.02 (*c*)	11.59 (Total force, including surface)	0.1244c. per lb. Cu.	Excluding depreciation and Federal taxes
Miami	.93	....	.72 (*c*)	29 (Men underground only)	0.10624c. per lb. 0.37c.	..... Straight mining does not include general overhead, which is 0.14857c.

(*a*) "Mining Methods at Morenci." *E. & M. J.*, Dec. 26, 1925.
(*b*) Mines Handbook, 1926.
(*c*) 1926 Annual Reports.
(*d*) "La Touche System of Mining," A.I.M.E. Tech. Pub. No. 20.
(*e*) "The Working of Unstratified Mineral Deposits." George J. Young.

Before the caving methods of stoping came into general use it was widely held that all medium and soft copper ore of a content of 4 per cent and more should be mined by some method requiring waste fill, in order to obtain more complete extraction. The filled methods were too expensive for ore below this grade, which therefore had

to be mined by some cheaper method requiring no fill and allowing the ground to cave as stoping proceeded. Top-slicing was therefore resorted to for all ores approximating 2 to 4 per cent copper content; the grades below 2 per cent were considered at that time to be non-commercial.

As improvements were made and cheaper methods devised, such as the caving systems, ore between 0.7 per cent and 2 per cent became commercial. Not only was it now possible to mine such ore profitably by methods that required no fill and permitted the back to cave, but the stages, a block, approximately 35 ft. high, equivalent to a sublevel, was taken as the limit of caving; later, this was increased to 75 ft.; and now it is found more economical to undercut a body as high as 300 ft. in thickness and draw the entire mass through the chutes beneath.

Ideal ore for the branch-raise system is ore that will cave readily, either because of its own weight or the weight of the overburden; then, as drawing proceeds from beneath the ore, the larger blocks will freely crush and disintegrate. Wet ore that packs or fine material that does not run freely on ordinary inclines of about

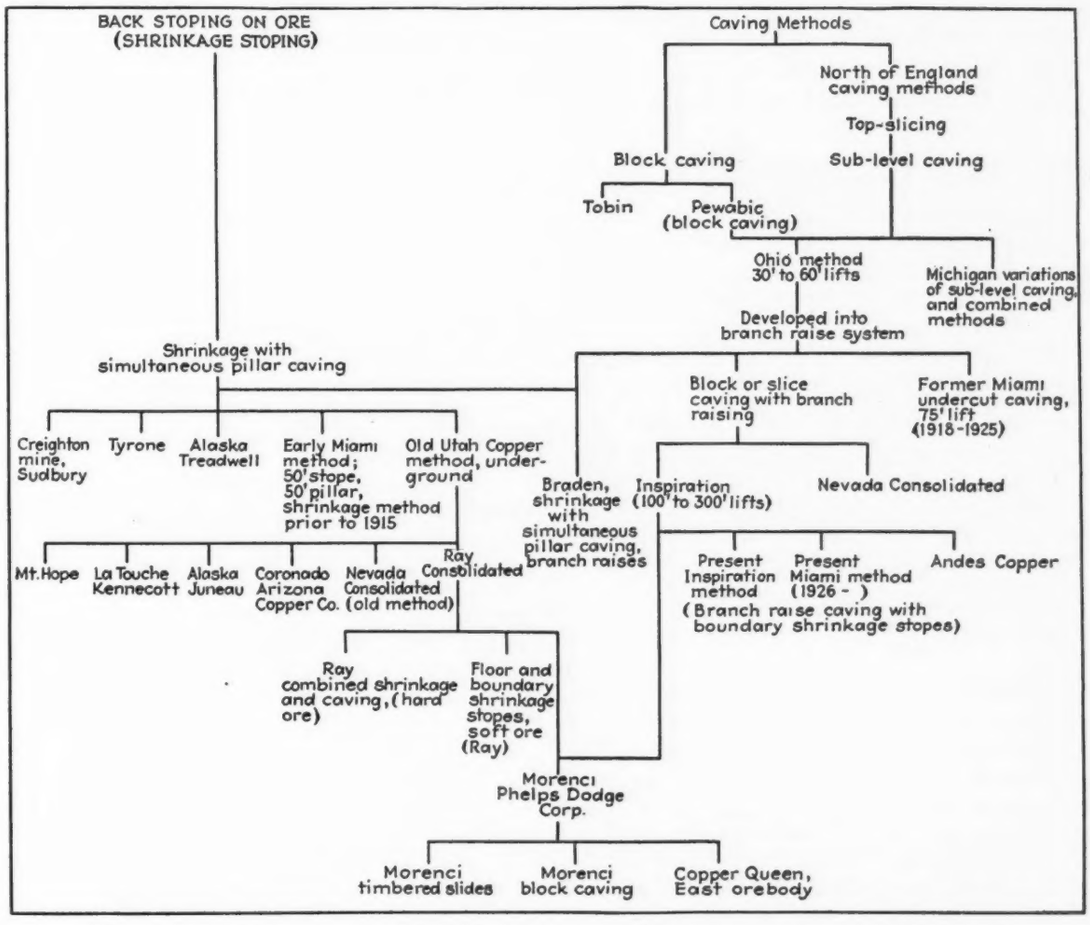

BACK STOPING ON ORE (SHRINKAGE STOPING)
Caving Methods
North of England caving methods
Top-slicing
Block caving
Sub-level caving
Tobin
Pewabic (block caving)
Ohio method 30' to 60' lifts
Michigan variations of sub-level caving, and combined methods
Developed into branch raise system
Shrinkage with simultaneous pillar caving
Block or slice caving with branch raising
Former Miami undercut caving, 75' lift (1918-1925)
Creighton mine, Sudbury
Tyrone
Alaska Treadwell
Early Miami method; 50' stope, 50' pillar, shrinkage method prior to 1915
Old Utah Copper method, underground
Braden, shrinkage with simultaneous pillar caving, branch raises
Inspiration (100' to 300' lifts)
Nevada Consolidated
Mt. Hope
La Touche Kennecott
Alaska Juneau
Coronado Arizona Copper Co.
Nevada Consolidated (old method)
Ray Consolidated
Present Inspiration method (Branch raise caving with boundary shrinkage stopes)
Present Miami method (1926 -)
Andes Copper
Ray combined shrinkage and caving, (hard ore)
Floor and boundary shrinkage stopes, soft ore (Ray)
Morenci Phelps Dodge Corp.
Morenci timbered slides
Morenci block caving
Copper Queen, East orebody

Fig. 5—Chart showing development of present caving and shrinkage-stoping methods

percentage of dilution of ore with waste was reduced to such a figure that these cheap methods became applicable to higher-grade ores, such as those between 2 and 4 per cent. Mining operators with long experience are now making the statement that had they high-grade orebodies which lent themselves readily to caving, they would cave them, regardless of the value of the ore, so sure do they feel that the dilution with waste can be kept to a minimum.

Caving systems are applicable to large, low-grade gold, iron, and copper deposits, where the ore is more or less homogeneous in character. They are being used more and more in mining limestone, and may later be applied to the mining of oil shale.

Height or thickness of ore is important for branch raising and shrinkage; 75 ft. to several hundred feet in height represents a satisfactory condition. In the early 55 deg. does not lend itself well to the branch-raise system.

In general, top-slicing and branch raising are applicable to the soft and medium ores; shrinkage with simultaneous pillar caving, which is a combined method, should be applied to ore that is a little harder. A few attempts have been made to apply the caving methods to hard ground, which would not come under a natural classification of "caving ground." Low-grade ore occurs in both hard and soft ground; but, in general, the deposits in hard rock are not of a size and shape that lend themselves readily to caving. Some few exceptions, however, exist, and even in the porphyry mines, small blocks of low-grade ore occur in extremely hard rock. These are so small that they do not justify a change in the stoping method, and consequently are caved along with the rest. It is, however, difficult, and somewhat more expensive,

to obtain an even draw when caving such hard blocks. An exceptional example is the Creighton mine, at Sudbury, where the combined shrinkage and caving method has been successfully applied in hard ore.

The tonnage produced by top-slicing, which is now almost entirely confined to the iron mines of Michigan, is not as large as that mined by either the branch raise or the combined shrinkage and caving methods. Ten years ago over 10,000 tons daily was stoped by this method at mines in the Southwest. Today, less than 1,000 tons is produced by this method, as the branch-raise system has largely taken its place.

Tonnages Produced by Caving Methods

The relative importance of these systems of caving may be noted from approximate tonnages at the various camps.

Table II—Tonnages Produced by Caving Methods

		Capacity Tons Daily
Branch Raise	Inspiration	22,000
	Miami	13,000
	Nevada Con. (underground mine)	3,000
	Morenci (soft ore)	1,500
	Andes Copper (*a*)	12,500
	Total	52,000
Combined Shrinkage and Caving	Ray Con. (hard and soft ore)	10,000
	Braden	12,000
	Alaska-Juneau	10,500
	Creighton, Sudbury	2,500
	Beatson-La Touche (Kennecott)	1,500
	Morenci (hard ore)	3,500
	Copper Queen (east orebody)	2,000
	Total	41,500
Other Methods Combined with Caving	Michigan (approximately)	20,000
	Minnesota (approximately)	3,500
	Total	23,000
Top-Slicing	Southwest camps (approximately)	1,000
	Michigan and Minnesota (approximately)	10,000
	Total	11,000

(*a*) Will produce this year.

From the above it will be noted that an approximate total of 127,500 tons is coming daily from all the caving methods. If the market conditions for copper and iron remain the same, or improve, this tonnage is more likely to increase than to decrease. Nevada Consolidated already has one underground mine in the Ruth and is contemplating decreasing the steam-shovel tonnage and greatly increasing that coming from underground. The same is true of Chino and of the Copper Queen branch of the Phelps Dodge Corporation. New Cornelia will eventually produce most of its ore from an underground mine and both Cananea and Morenci have great potential caving orebodies, which have not yet been brought to the producing stage.

Although shrinkage is the method most generally combined with caving, particularly in the low-grade porphyry deposits, in the Michigan iron mines other combinations are in use, such as top-slicing and caving, generally known as "sublevel caving." In such cases, short lifts are taken, the vertical height of the ground caved ranging generally from 16 to 20 ft.

Costs

The lowest costs are usually obtained with the branch-raise system. Where shrinkage is combined with caving, the costs are generally higher, owing, frequently, to mining in harder ground. Top-slicing, on account of the large amount of timber required, is the most expensive, especially when stopes are carried on the horizontal. Branch-raise costs range from 37 to 96c.; combined shrinkage and caving, with one exception, from 60 to $1; and top-slicing usually costs anywhere from $1 to $2.50 a ton.

The degree of safety in mining by the caving systems approximates that of other proven methods. Accidents which have occurred are, mainly, in connection with transportation, on the haulage levels.

Modification of Caved Stopes

The division of caved stopes described above have a number of modifications as given in Table III.

Table III—Modifications of Caving Systems

Branch-raise caving method	Variations used at	Inspiration Miami Copper Phelps Dodge, Morenci Nevada Con.—Ruth mine Andes Copper
	Sublevel caving with branch raise	Northern Michigan
Combined shrinkage and caving	Floor and boundary shrinkage stops with overhead caving	½ Ray, soft ore.
	Shrinkage stopes with simultaneous pillar caving	Braden; Alaska Juneau; ½ Ray, hard ore; Phelps Dodge, Morenci branch; Creighton mine, Sudbury; La Touche (Kennecott), Alaska.
Sublevel caving	Hand tramming Scraper methods	Michigan and Minnesota
Top-slicing	Horizontal	Athens mine, Negaunee, Mich.
	Incline	Oversight, Cananea. Arizona Copper, Coronado

The branch-raise methods in use at the five porphyry camps mentioned above are all based upon the same fundamental principles. There are, however, certain variations in the manner in which the details of the general development plans are carried out. These variations, though interesting and of a constructive nature, are not sufficiently distinctive to justify individual terminology.

Trend Toward Combination of Technical Methods

Some years ago it could be said that one porphyry orebody was being mined by the branch-raise system, while another used shrinkage with simultaneous pillar drawing, a totally different method. Recently it has been found that a small amount of shrinkage (in the form of boundary shrinks), combined with the branch raising, facilitates caving and gives better extraction. Likewise, in the shrinkage camps, it was discovered that it was not always necessary to carry shrinkage the entire height of the stope in soft and medium orebodies, but that after carrying the shrinkage up from 10 to 50 ft., the remainder of the stope might be caved and drawn, similar to the branch-raise system. During the last six months this has been found possible, not only in soft and medium ores but also in what is known locally as hard ore. Therefore, as time goes on, the methods in use at all of the underground porphyry mines will be largely combined, rather than distinctive methods. (Note the detail in Fig. 5, on page 367.)

Details of the division of caved stopes will be described in future articles to be published in *Engineering and Mining Journal.*

Copperton—

A Model Home Town for Utah Copper Employees

By William Spencer
Utah Copper Company, Salt Lake City, Utah

COPPERTON, a settlement of Utah Copper Company employees, situated at the mouth of Bingham Canyon, may be described as an overflow from the town of Bingham; so, to show the reason for its existence, it is necessary to go briefly into the history of that old mining "camp."

The Oquirrh range of mountains was one of nature's great uplifts, some of the peaks rising to over 10,000 ft. above sea level. Near the northeast end of this range, nature's forces, working through countless ages, have eroded Bingham Canyon, which for 6 miles splits the mountains and in places is hardly 100 ft. wide in the bottom, with the sides rising on steep slopes to the top, 1,500 to 2,000 ft. higher. Up this canyon in September, 1863, came General Conner and 24 others to locate the Jordan mine, the first recorded mine location in Utah. Other miners followed, and gradually a small settlement was established at the junction of Carr Fork with the main Bingham Canyon, midway in the canyon's length. This settlement is now known as the town of Bingham. There was room for only one street, and the back yards of the houses extended up the steep mountain slopes.

With the completion of the Bingham and Camp Floyd Railroad to the lower end of Bingham, in 1873, mining activities increased, and many mills and smelters were constructed. In the late nineties, production increased beyond the capacity of team haul, so the railroad was extended up into the canyon as a horse tram, and later aërial trams were constructed. All this added to the population, and the housing situation became a serious question.

Utah Copper was formed in 1903. The original holdings of mining claims of this company covered 192 acres, later increased by purchase and consolidation to 1,488 acres.

Development showed that the whole mountain between Carr Fork and Bingham Canyon was a mass of ore containing small particles of copper. The ore was so low in grade that large-scale production was necessary to obtain a profit.

There was no room within the confines of the canyon for the construction of large mills, so two more lines of railroad were built along and through the sides of the mountains to the heart of the orebody, from which point a system of switchbacks carries standard-gage cars to the very top of the mountain, some 1,500 ft. higher. The railroads transport the ore 22 miles to the mills at Garfield, and there connect with the transcontinental railroads of the country.

All the near-by gulches were utilized for the storing of the millions of tons of waste and only the knolls and bottom of the canyon were available for building sites. Here comfortable houses of brick and stucco, the Robert Gemmell Memorial Club House, hospitals, apartments, garages, and the business buildings of the district have been constructed; but the buildings are strung along for three miles, the roads are congested, smoke from the locomotives settles down in the canyon, and it is impossible to keep the children from playing in the road. It is no wonder that the problem of living conditions reached the stage where something had to be done to relieve and improve the situation.

Utah Copper recognized that improvements at Bingham had created a better condition for the employees, but that these improvements had been carried on about as far as was practicable in the confines of the canyon. The company officials, convinced that a pleasant home life went a long way toward maintaining a better spirit and confidence of the workmen, in itself an asset to a company which has still 30 years of life ahead of it, found a solution of this problem, in the townsite of Copperton.

Though Bingham Creek still flows down the bottom of a deep gulch, the mouth of Bingham Canyon is generally considered to be at the foot of the precipitous slopes of the mountains rising from the Salt Lake Valley. The valley slope is gentle, much like the bench lands in Salt Lake City, and the outlook is across 20 miles of valley, with the background of the beautiful and imposing Wasatch range of mountains.

Copperton lies by the side of a concrete highway, over which some 28,000 tourists yearly ascend the canyon to view the operations of the Utah Copper Company. Incidentally, advantage was taken of this fact to advertise the endurance of copper metal used in building operations.

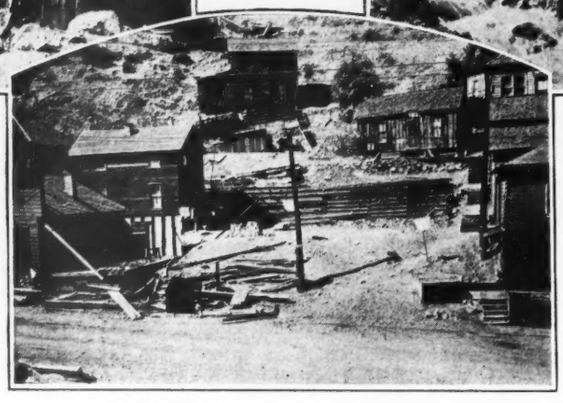
The first contract called for eighteen houses, some of five rooms and some of four, to be constructed of hollow tile with stucco finish, and 25 more were built during the last year. Yearly additions will be made as the need is demonstrated.

All the houses are modern, particular attention being given to the kitchen layout and built-in features. Bath rooms are models of convenience and furnished with the best of fixtures. Basements are concreted, well lighted and have laundry, furnace, and fruit rooms. Furnaces are of the hot-air type and the superintendent's house boasts an oil-burning furnace.

To illustrate the use of copper in the building of homes

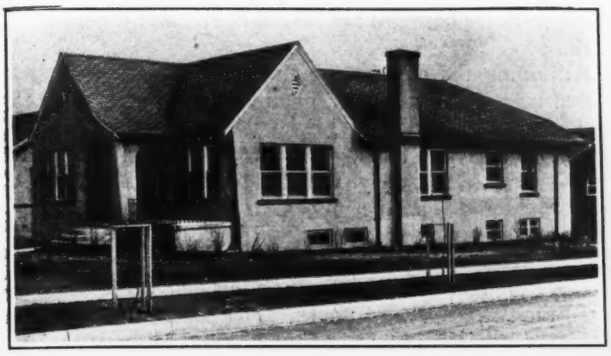
Utah Copper Mining Towns—Old and New

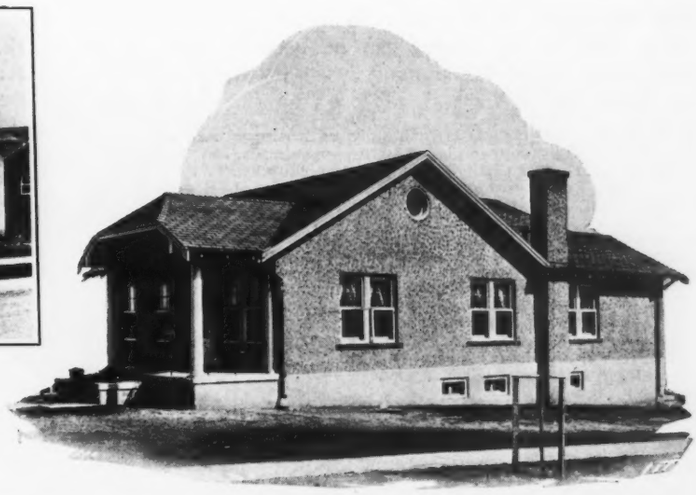
Copperton, Model Industrial Settlement, Contrasts With Congestion in Bingham Canyon



The three small photographs show typical conditions in the canyon. Note the stream in the right-hand view and the congestion of houses on the steep hillsides; also the rope tramway above

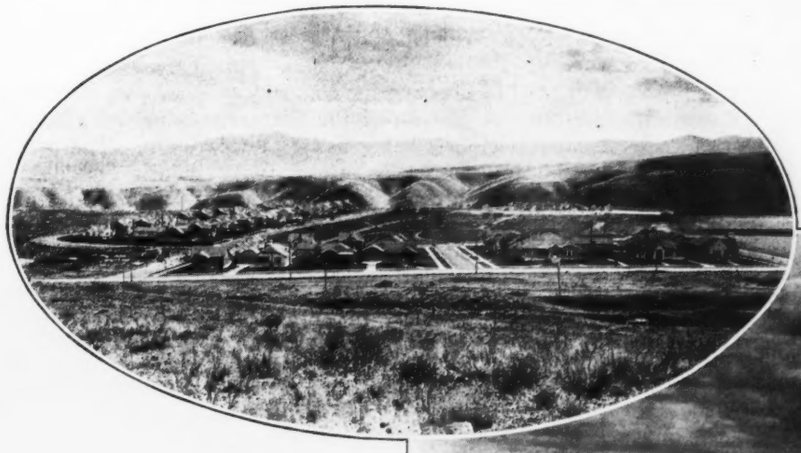
Below, the Utah Copper mine with the town of Bingham in the bottom of the canyon. At the left are the dumps for capping; on the right, the trestle and tracks of the B. & G. railroad

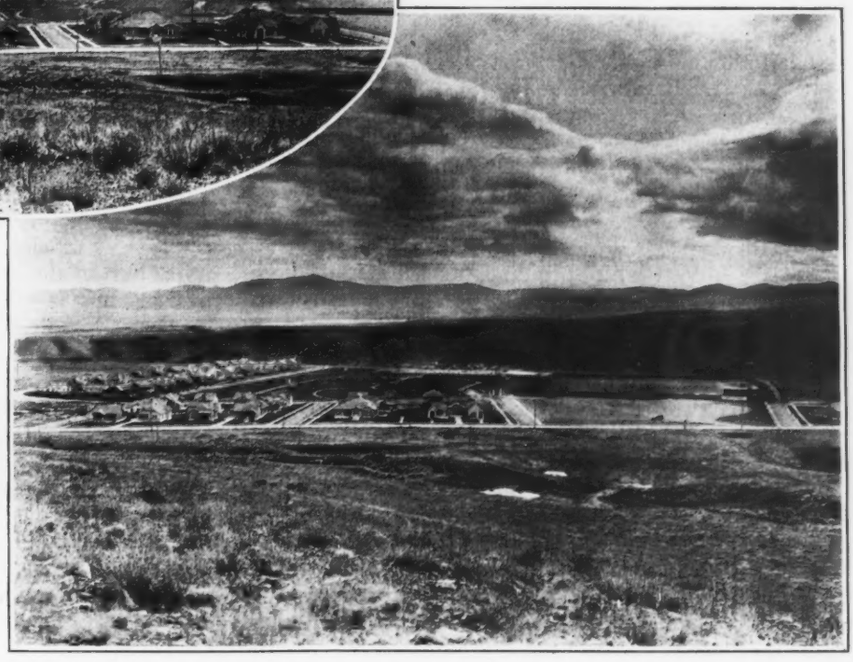




Two of the model dwellings at the new town of Copperton

Above, general view of the settlement with the snow-clad Wasatch Mountains 20 miles away in the background





Two other photographs of the town. The park and the athletic field at the right are important features of the model settlement

the following extracts from the specifications show how this "ever-lasting" metal can be used to displace the perishable material commonly used in the construction of buildings.

Roofing: Copper-clad strip shingles with copper nails.
Valleys: Sheet copper placed with copper nails.
Hips and ridges: Cut from copper strip shingles.
Flashing and counter flashing: Sixteen-ounce sheet copper.
Downspouts: Sixteen-ounce sheet copper.
Gutter straps: Sixteen-ounce sheet copper.
Downspout stays: Ornamental copper castings.
Chimney saddles: Sixteen-ounce sheet copper.
Kitchen vents: Copper globe ventilator and pipe.
Toilet vents: Covered with genuine bronze fly screen.
Door and window screens: Sixteen-mesh, genuine bronze.
Plumbing: All pipe of brass with brass fittings.
Showers: All brass combination shower and needle bath.
Toilets: Brass hinges and floor flanges.
Building hardware: Bronze plated.

Such use of copper in building construction increases the initial cost, but this extra cost would be offset in a few years by the maintenance and depreciation costs of the cheaper and more perishable building materials. Careful cost data were kept during the construction of the first unit of eighteen houses and it was found that by the use of copper as shown in the specifications the extra cost was about $310 per building, which means an initial extra cost of 5.8 per cent over what the more perishable material of ordinary construction would cost.

The company has acquired water rights in several wells in the center of Bingham Canyon about a half mile from the townsite. This supply of pure water is pumped into reservoirs, and the connecting pipe system furnishes water to the houses.

The main water line from the reservoir is an 8-in. wood-stave pipe. There is also a 10-in. wood-stave pipe, used for draining and flushing the reservoir. The distributing system at the townsite is of wrought-iron and cast-iron pipe. Galvanized-iron pipes are used for the house connections up to within five feet of the houses, where the brass pipes of the house service begin.

The street parking, lawns and Community Park are equipped with a sprinkling system, galvanized-iron pipes being used. All the houses are connected with a modern sewage system.

Electricity is supplied by the Utah Power & Light Company to the houses by wires in underground conduit. The absence of poles adds much to the neatness and general appearance of the town.

The first unit of the town borders on the south side of the State Highway. Connecting streets are 26 ft. wide, with gravel pavement on a sub-base of coarse-crushed rock. Streets are curbed and guttered. Gutters have connections by storm drains with the main sewer line. Sidewalk and house approaches are of concrete. Parkings between the sidewalks and curb are seeded with grass and planted with trees, spaced every 20 ft. This space is equipped with sprinkling devices, as the location is in the arid belt and all vegetation must be irrigated.

Realizing the necessity of outdoor recreation as well as housing, the company has laid out a park covering seven acres. The park is traversed by winding walks lined with shade trees of every available variety. Thousands of shrubs have been planted and the whole has been seeded with bluegrass. The entire park as well as the street parking is equipped with sprinkling devices.

A circular concession stand is located in the center of the park, with two comfort stations, built to match the architecture of the houses. A strip on the south is being reserved for a children's playground and is fully equipped with the latest devices for the amusement of the youngsters. There are two tennis courts and the baseball park.

Adjoining the entrance to the baseball park is an inclosed tract 300 by 300 ft., filled in with coarse, crushed rocks and surfaced with gravel. This is inclosed with heavy woven-wire fencing supported on iron-pipe posts and is used exclusively for the parking of autos. A school building is in the process of erection, but at present the children are transported by trucks to and from the Bingham schools.

The Bingham Stage Line runs a bus between Salt Lake and Bingham every two hours. The distance to Copperton is 23 miles, and as the time is only 45 minutes, the town might be considered a suburb of Salt Lake City.

The town is not an incorporated village; it is under direct control of the Utah Copper Company. No one lives there but Utah Copper employees, and as yet there are no stores, the supplies being obtained from trucksters and by delivery from Bingham. Eventually houses for all employees whose constant presence at or near the mine is not necessary will be provided.

Copperton will be a town of families—there will be no room for the floater, the pool-room habitué, or the bootlegger. True, these will be only three miles away, but their influence will be negligible. Salt Lake City is near enough and of such accessibility that the monotony of village life is easily broken Truly, one can foresee for Copperton a colony of real homes and children fitted in body and mind far better than the child living under the conditions that prevail in the ordinary mining camp.

General Chemical Company to Develop Virginia Pyrrhotite Ore

ALFRED TELLAM, of the General Chemical Company, 40 Rector St., New York City, is developing a method of dressing the company's Galax (Va.) pyrrhotite ore. A portion of the State Experimental Plant at Golden, Colo., is being used for this work. The ore is pyrrhotite, closely associated with chlorite and mica schists, containing very small amounts of copper and zinc. The presence of the mica and the need for nearly complete elimination of the copper and zinc in the iron product give the problem several interesting angles.

Mr. Tellam reports progress in a scheme of treatment whereby he expects to remove first a clean mica product followed by flotation to remove the copper, zinc, and iron in successive stages. The mica will find utilization in the manufacture of asphalt shingles; the pyrrhotite concentrate will be roasted to produce sulphuric acid, and the residue or clinker will be shipped to Pittsburgh for utilization in the iron blast furnace. The value of this iron product is greatly enhanced if the zinc and copper content is less than one-tenth of 1 per cent, and selective flotation has made such a separation possible. Copper concentrate produced will contain 13 to 16 per cent copper, 28 to 35 per cent iron, and less than 10 per cent zinc. This concentrate will also be utilized in the acid plant and a market for the residue found on the Atlantic seaboard. A low-grade zinc product will be produced, which may be roasted for recovery of the sulphur content, but otherwise will be of no value.

Preliminary plans call for the erection of a concentration plant with a capacity of 1,000 tons per day. Final details await the completion of the preliminary testing campaign.

Status of Leached Outcrops Investigation

PART II

By ROLAND BLANCHARD and P. F. BOSWELL
Duncan, Ariz.

EFFECTS of a mixture of pyrite with chalcocite upon the resulting oxidation products have been discussed. It has been shown that as the pyrite content increases beyond a certain ratio, the difficulty of interpreting the resulting limonite product, although interpretation still is possible in most cases, likewise increases. This same condition holds for mixtures of pyrite with the other four sulphides discussed (chalcopyrite, bornite, sphalerite, and galena), except that in the case of the last-named sulphides the ratio of pyrite to any of them, at which obliteration of the characteristic limonite texture begins, varies with the particular sulphide. From this it might be expected that where a mixture of other sulphides, such as sphalerite and chalcopyrite, or sphalerite, chalcopyrite, and galena, occurs, the resulting oxidation solutions would mix to such an extent that none of the limonite types characteristic of the individual sulphides would be preserved. To a limited extent this is true. It is frequently, though not invariably, true where the respective sulphides are fine grained and intimately intergrown; but field evidence shows that where the respective sulphide nodules are more than ¼ in. in diameter, the oxidation solutions commonly mix only at the border of those nodules; and that if the limonite mass be closely examined, there will be found in place the respective limonite types corresponding to the sphalerite, chalcopyrite, galena, or other sulphide of the unoxidized specimen. Excellent examples occur at the Pride of the West mine, Duquesne, Ariz.; on Mammoth Hill, at Johnson, Ariz.; and at several zinc-copper prospects in southwestern Chihuahua, in which mixtures, made up of nodular masses 1 to 2 in. in diameter, of sphalerite, chalcopyrite, and pyrite, oxidized to their respective limonite types, in each case without infringement upon adjacent nodules and without obliteration of the characteristic limonite texture in any case. A good example of chalcopyrite and pyrrhotite, oxidizing similarly, occurs at the Rocher de Boule mine, in British Columbia.

Excellent examples of mixed sphalerite and galena, and of sphalerite, galena, and pyrite, oxidizing so as to leave their respective limonites in this way, occur at Chlorite, and at Aravaipa, Ariz., and in parts of the Yaqui River country in east-central Sonora, Mexico.

Field evidence, therefore, forces the conclusion that where the sulphide mixtures are massive, with the nodules upward of ¼ to ½ in. in diameter, oxidation of a given sulphide nodule commonly goes on independently of oxidation in the surrounding nodules of other composition. This is not an invariable rule, but it is usual enough to serve as a guide in field work. It explains why at Sacramento Hill, at the United Verde orebody, and in the limonite outcrops over the Granby orebodies at Anyox, evidences of former chalcocite or chalcopyrite, or both, were prominent in the leached outcrops even though an overwhelming amount of pyrite had been present in the sulphide ore prior to leaching.

Fig. 8—Botryoidal limonite crusts derived from massive pyrite in limestone gangue

The acid solutions from the oxidizing pyrite were so strong that they overwhelmed the neutralizing power of the limestone. This specimen comes from the base of an oxidized, massive pyrite body more than 50 ft. in diameter. Gardner mine, Bisbee, Ariz.

A suggested explanation for the more common obliteration, by pyrite limonites, of the copper sulphide limonites in disseminated deposits is that in such deposits the pyrite nodules are smaller in volume; that they are often more intimately intergrown with the copper or other sulphide; and that consequently they are less likely to oxidize independently of the copper or other sulphide. Where such intimate intergrowth occurs in the massive type of deposit, partial obliteration of limonite texture likewise is common. It rarely happens, however, in either case, that evidence of former copper, zinc, or lead minerals is completely destroyed if those minerals were present in amounts sufficient to constitute ore.

The influence of neutralizer has been already discussed, to some extent, and it has been shown that where the acidity of the solutions is high, as in the oxidation of pyrite or of mixed sulphides with high pyrite content, little or no limonite is likely to be precipitated unless neutralizer is present in the gangue or in surface waters with which the oxidation solutions come in contact.

In a pure quartz gangue no neutralizer is present, and, in such a gangue, pyrite, upon oxidizing, usually leaves no limonite unless during the oxidation the gangue was traversed by surface waters carrying neutralizer, such as calcium carbonate, in solution. See Fig. 4.

In a monzonite or other gangue rich in feldspar, a limited amount of neutralizer is present, and such gangues are usually spoken of as gangues of moderately slow neutralizer. For the most part they have little effect upon precipitation of limonite until after the solutions resulting from the oxidation have left the cavity and come in contact with the feldspar. Then precipitation of limonite takes place, and the distribution of the limonite around the cavity depends chiefly upon the acidity of the solutions. With high acidity, as when pyrite is oxidizing, the iron-bearing solutions may travel outward into the gangue as much as ¼ in. before the neutralizer of the gangue overcomes the high acidity and brings about precipitation of limonite. Such a case is illustrated in Fig. 9. With lower acidity, as in the case of oxidizing chalcopyrite, precipitation of limonite may occur heavily at the edge of the cavity, and gradually lessen outward until all the iron from the solutions has been dropped. Such a case is illustrated in Fig. 10. With very low acidity, as in the case of a 1:1 mixture of pyrite and chalcocite oxidizing, precipitation of all the limonite that has not already taken place within the cavity may occur immediately at the edge of the cavity—or as soon as the oxidation solutions come in contact with the gangue. Such a case is illustrated in Fig. 11.

In a limestone gangue, neutralization by the calcium carbonate is very rapid, and limestone is usually spoken of as a gangue of rapid neutralizer. The purer the limestone, the more rapid the neutralization. So effective is calcium carbonate as a neutralizer that where disseminated pyrite and chalcopyrite oxidize side by side in a limestone gangue, all the migrating iron, with respect to the pyrite, is likely to be precipitated as limonite immediately at the edge of the cavity exactly as it is in relation to the chalcopyrite; and in both instances much limonite is likely to be precipitated within the cavity before migration, as the result of infiltrating neutralizing solutions during oxidation. In such a condition the pyrite and chalcopyrite limonites cannot be distinguished from each other merely on the basis of their distribution around the cavity. But, as discussed presently, some clue besides the distribution may serve to fix the origin of the limonite.

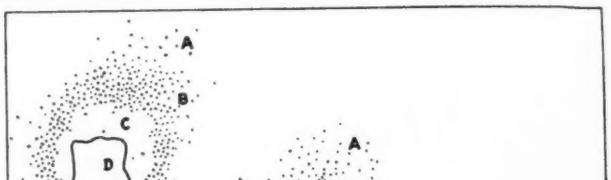


Fig. 9—Showing characteristic oxidation of disseminated pyrite in gangue of moderately slow neutralizer, such as monzonite

A, outer zone of lean limonite precipitation. B, intermediate zone of heavy limonite precipitation. C, inner zone nearly free from limonite precipitation. D, cavity leached of pyrite and free of limonite. X5.

Fig. 10—Showing characteristic oxidation of disseminated chalcopyrite in gangue of moderately slow neutralizer, such as monzonite

A, outer zone of lean limonite precipitation. B, inner zone of heavy limonite precipitation. D, cavity leached of chalcopyrite. E, small amount of fine cellular limonite left within the cavity by the leached chalcopyrite. X5.

Fig. 11—Showing characteristic oxidation of a 1:1 mixture of chalcocite and pyrite disseminated in gangue of moderately slow neutralizer, such as monzonite

B, zone of moderate limonite precipitation. D, cavity leached of the 1:1 mixture of chalcocite and pyrite. E, cellular limonite of chalcocite derivation lining most of the cavity. X5.

The strength of calcium carbonate as a neutralizer frequently prevents development of the characteristic limonite types for a given sulphide. Because of the extremely rapid neutralization, these do not have time to form, and there is developed instead a specific type of pulverulent, fluffy limonite that under the hand lens resembles powdered sugar sprinkled over a surface. The fluffy limonite is the same in physical appearance regardless of whether the iron was derived from pyrite, chalcocite, chalcopyrite, siderite, magnetite, or any other mineral yielding limonite upon oxidation. By itself it signifies nothing more than that an iron-bearing solution of indefinite source came in contact with strong neutralizer. This would apparently make any effort to interpret intelligently a limonite precipitated in a limestone gangue hopeless. But it is not hopeless. Often there is preserved within the mass of fluffy limonite some original structure of the iron-yielding mineral that furnishes a definite clew. An example is illustrated in Fig. 12, where the rhombohedral cleavage structure of the siderite is plainly preserved, even though the siderite itself has completely gone to limonite.

Usually, too, where the larger nodules of sulphide oxidize in a limestone gangue, the neutralizing effect of the calcium carbonate definitely manifests itself only around the edges of the nodule where the sulphide comes directly in contact with the limestone. If the entire limonite mass representing the former sulphide nodule be broken into, the central portion generally is found to contain the type of limonite characteristic of the sulphide or sulphides that have been leached. Only in formations where the sulphide is finely intergrown with the limestone gangue is serious difficulty likely to be encountered in

the interpretation. This is especially true if sulphides such as chalcopyrite or bornite occur finely intermixed with a large excess of pyrite and if all the sulphides are finely intergrown with the limestone gangue. But even such cases are not hopeless. At Bisbee, over the massive sulphide bodies in limestone of this type, the leached gossans rarely fail to show distinct evidence of chalcopyrite, bornite, or chalcocite limonites, in those occurrences where the grade of copper beneath is sufficient to constitute ore.

One point must be emphasized: In limestone deposits the neutralizer often does penetrate well into the central portions of the oxidizing sulphide nodule even where these nodules are several inches in diameter. If this were not so, large cellular limonite masses probably would not

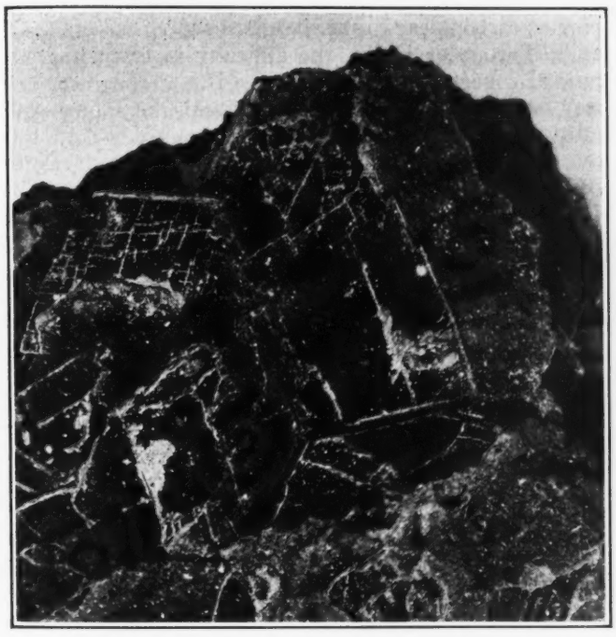


Fig. 12—Limonite derived from siderite

Note the well-preserved rhombohedral cleavage structure, even though the siderite is completely altered to limonite. The groundmass of this specimen is composed of the fluffy limonite type precipitated by strong neutralizer. X3. Jubilee prospect, Wenden, Ariz.

be left where massive pyrite has oxidized in a limestone gangue. See Fig. 13. What is meant here is that in most occurrences of the coarser nodular sulphide masses the effects of neutralization are not pronounced enough beyond the borders of the oxidizing sulphide nodule to obliterate or prevent formation of the characteristic limonite type for that particular sulphide.

A warning must be given: The characteristic limonite type in any case must be clearly distinguished. It was stated in Part I that in disseminated deposits in monzonite the presence of cavities filled with a particular type of limonite (shown in Fig. 2) meant a ratio of 2 chalcopyrite : 1 pyrite. At Bagdad some portions of the disseminated areas show this condition, and for such areas that ratio of chalcocite to pyrite obtains. But near by is an area in monzonite, along a minor fault, in which the cavities formerly occupied by sulphides are similarly filled with limonite. This area has no promise for copper. The difference is that in this last-named occurrence the limonite filling the cavities is not the chalcocite type illustrated in Fig. 2, but the fluffy type characteristic of precipitation by rapid neutralizer, shown in Figs. 7 and 12. The absence of copper color in the flame test, applied in repeated instances to the fluffy limonite here, signifies the absence of copper; for where copper has been leached from a cropping we never have found a case in which sufficient copper did not remain in the limonite to show up in the flame test. In this particular instance, other field evidence points convincingly to the absence of copper along the fault, and investigation shows that, during oxidation, surface waters rich in calcium carbonate, coming downward along the fault from overlying limy gravels, provided strong neutralizer; and that this neutralizer infiltrating into the sulphide cavities during oxidation, precipitated the fluffy limonite in place. See Fig. 7. Had there been no field evidence against the presence of copper along this minor fault, and had the flame test revealed the copper color in the limonite, this particular area could not have been condemned; for the fluffy limonite might have been precipitated from iron-bearing solutions derived from chalcocite or chalcopyrite as well as from those derived from pyrite or other sources.

The presence of neutralizer is important in the interpretation of leached outcrops beyond its effect in precipitating the limonite. At Miami neutralizer in the gangue is so low that little or none of the dissolved copper is precipitated from solution until the secondary chalcocite zone in depth is reached; copper is rarely marooned in the cropping as carbonate or other oxidized copper mineral.

At Ajo neutralizer in the gangue is so high that essentially all dissolved copper is precipitated from solution at or very close to its sulphide source, as carbonate or other oxidized copper mineral, and is not available to form a secondary chalcocite zone beneath. This explains why the grade of the oxidized ore at Ajo is the same as that of the unleached primary ore. Secondary enrichment has not occurred; there has been merely a change from primary copper to oxidized copper without addition or subtraction in copper value. With the combination of Ajo's gangue and Miami's primary sulphide deposit, a secondary chalcocite orebody never would have resulted, because concentration of secondary copper in depth as chalcocite could not have occurred. With the combination of Miami's gangue and Ajo's primary sulphide

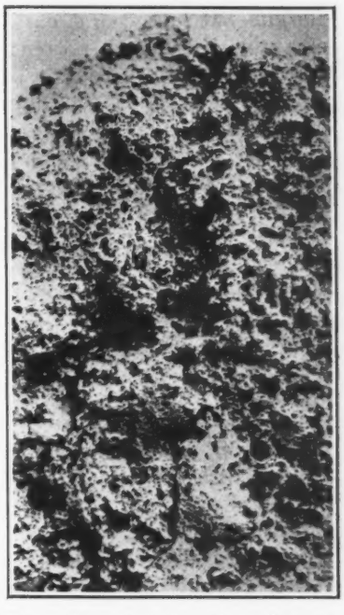


Fig. 13—Cellular limonite derived from massive pyrite oxidizing in limestone

Note the thick-walled cells with irregular, rounded cell openings. Compare with the more angular, thin-walled cellular structure shown in Fig. 2, 3, and 4. This type of limonite is common where massive pyrite bodies oxidize in limestone, but acidity of the oxidation solutions in this case is less than in the case represented by Fig. 8. Note total absence of fluffy limonite in this nodule. X2. Outcrop near Lluvia de Oro mine, Chihuahua, Mexico.

deposit, and with an amount of erosion equal to that at Miami, a secondary chalcocite orebody would have been formed rivaling in richness United Verde Extension.

Utah Copper (excluding the quartzite areas), Tyrone, Silverbell, Bagdad, Chino, and the Zonia prospect in Yavapai County, Ariz., are examples in which more neutralizer is present in the gangue than at Miami, but less than at Ajo. And at each of these places oxidized copper minerals such as carbonate, silicate, and others are present in the leached cropping in proportion to the amount of neutralizer or other precipitant in the gangue, while a corresponding amount of copper is withheld from the secondary chalcocite zone.

From this discussion it is evident that determination of the amount and character of neutralizer in the gangue, and knowledge of its effect upon the solutions resulting from the oxidation, are as important in the interpretation of leached outcrops as is the ability to recognize the particular types of limonite produced.

Limonite Color is Often Characteristic

In particular districts, and to some extent throughout western North America, certain colors of limonite are characteristic. For example, the brick-red color of limonite never has been found by us over areas carrying sufficient copper to constitute ore; where it does occur, the primary sulphide is usually predominantly pyrite, and the copper content is very low or absent. A maroon to seal brown color is usual for limonites derived from disseminated chalcocite in monzonite, but is by no means universal. An orange-ocherous color is common in limonites derived from galena, but this color is characteristic also of certain limonites derived from bornite.

On the other hand, limonites derived from a single sulphide, either in the same or in different districts, vary greatly in color. At Silverbell the pyrite areas in the alaskite have a general dark reddish color; the pyrite areas in the alaskite porphyry, which is finer grained, have a general ocherous to buff color.

Limonite color is determined largely by (1) amount of adsorbed and capillary water present in the limonite; (2) state of aggregation of the limonite particles; (3) size of the limonite grains. A reddish or orange limonite ground sufficiently fine becomes ocherous. Ground still finer, it becomes yellow. Many other conditions, such as variations in the acidity of the solutions, rapidity of neutralization, or adsorption in the case of well-kaolinized gangues, affect grain size and govern the amounts of iron and water which enter into the formation of the limonite. For this reason the persistence of certain colors over wide areas and under different climatic conditions would not be expected. That they do so persist in many instances shows that the range of conditions under which the various sulphides oxidize in nature is more limited than one would expect from the number of variables involved.

It should be emphasized, however, that color in limonite in any instance serves only as a clew to the limonite's origin. Accurate determination of the origin rests upon recognition of the texture and "type" and upon knowledge of the chemistry and physics of the processes which produced that particular material under the conditions existing in the outcrop during oxidation.

Morse, as an experiment several years ago, sought to determine, solely from the evidence contained in the leached outcrops, what the ratio would be for concentrating Miami ore. His results checked closely those actually obtaining in milling practice at Miami. This sounds suspicious, because the ratio of concentration here was already known. To attempt it where no milling tests have been carried on would seem more formidable.

The process is really quite simple. For, with the character of the gangue known from examination of the outcrops; with the fact determined, from examination of the limonites, that the ore carries only chalcocite and pyrite; with the ratio of these two sulphides determined from recognition of the limonite types present and their distribution with respect to the cavities; with the grade of the ore estimated from these various factors; and with a knowledge of modern milling practice, nothing remains but simple arithmetical calculation.

Where much neutralizer is present in the gangue, so that part of the leached copper is marooned in the cropping as carbonates or other oxidized copper mineral, such as at Tyrone or Chino, the difficulty in calculating the ratio of concentration is increased. But although the case may not be as simple as that at Miami, the approximate ratio of concentration may be determined. And this, too, where the ore has not been seen or even developed and where the leached croppings alone are the guide. Ten years ago such a thing was not thought to be possible. It would have been ridiculed had it been suggested. That today it is regarded as merely an incidental connected with the interpretation of a leached outcrop serves to emphasize the progress that has been made.

Application of Leached Outcrops Data

Not long ago we were called upon to assist in laying out the exploration program in a certain disseminated copper district of the Southwest. A half day's examination of the surface showed that exploration was not proceeding beneath the more promising surface croppings; it was proceeding into "D" ground, or into an area that on the surface showed no promise whatever for copper. The suggestion was made that this work be discontinued and exploration be directed beneath a near-by cropping classified by us as "A." The local management, not convinced, continued the old program for two months, and found only barren rock. The recommendations were then carried out, and commercial ore was found beneath the area mapped as "A" croppings. Furthermore, when the exploration program was laid out, the probable length of this particular oreshoot was predicted, based on surface evidence. The actual length is within 5 per cent of the prediction, in an orebody nearly 500 ft. long.

Another instance: An exploration company spent $60,000 prospecting, in part, a disseminated chalcocite area in the Southwest. We were not called in on this program, but walked over the ground merely as visitors. It became obvious at once that exploration was proceeding into "C" and "D" ground, and that the only area of possible promise lay several thousand feet away, still on the property. This was tentatively rated by us as "B" cropping. The company in question abandoned the prospecting four months later, without having tested the "B" area. Several drill holes put down by other parties at this place show an average of slightly more than 1.25 per cent copper, as chalcocite. In this case classifying and mapping the leached chalcocite areas for the entire property would have required the services of one man for probably two weeks, provided accurate base maps were available. Application of the resulting data would have saved $60,000 in exploration costs. But that is not

the main consideration. Had the outcrops in the favorable area rated an "A" instead of a "B" classification, and promised a slightly higher grade of copper, the opportunity would have been present to develop a profitable porphyry copper mine in ground which a major copper exploration company had abandoned as hopeless.

The impression should not be gained from this that the leached outcrops data are useful only in the examination of disseminated chalcocite deposits. Their application to these has proved especially successful because the chalcocite limonites are the easiest to interpret and because up to eighteen months ago more time had been devoted to disseminated chalcocite deposits than to any other type. With the inclusion within the last two years of the lead and zinc minerals, and the massive types of the copper and iron sulphides, the field for applying the leached outcrops data has greatly expanded. This later knowledge is now being used to direct exploration programs.

Our investigations are at present concentrated upon the problem of the differentiating of the limonite products derived from the six sulphides here discussed and those of some twenty other sulphide and non-sulphide minerals whose oxidation products they somewhat resemble. Careful differentiation is necessary if accurate interpretation of the leached outcrops is to be assured.

Present investigation is not confined to outcrops representing leached sulphides. Other types of outcrops over orebodies, such as the fissure silicifications overlying the Bisbee "far-traveling" copper deposits in unaltered limestone, are being investigated in other districts. At some future time a paper will be forthcoming showing that no real mystery attaches to this type of outcrop; that such outcrops are merely modified expressions of garnet-epidote zones, and may be judged accordingly. Much more field work must be done, however, before the results in this research are published.

The ultimate goal, therefore, of the present outcrops investigation is not merely the differentiation of the various limonite types derived from leaching of sulphides and other iron-yielding minerals, but the development of a sound basis for translating all types of outcrops over orebodies into terms of ore beneath.

Sulphur in China

THE sulphur utilized in China as an ingredient in black powder and fireworks consumes perhaps more than half the total production. A small part is used as fertilizer and a still lesser quantity is employed in the chemical, textile, and other industries. Because of its importance in making munitions, the sulphur is usually mined and sold under the fixed control of government authorities. Those intending to enter the business should first get official permission from the local officials, according to W. H. Wong and C. Y. Hsyieh, of the Geological Survey of China, in a paper entitled "The Pyrite Deposits and Sulphur Industry of China," contributed to the Fourteenth International Geological Congress. Official sulphur bureaus are established in almost all the sulphur-producing provinces. The bureaus are also in control of the saltpeter industry, which is another important ingredient for making black powder. Pyrite deposits constitute the principal source of sulphur in the country. They are widely distributed, and so far as known, of small size.

Uses of Tantalum

FOR LABORATORY and industrial uses, a marked demand has arisen for a metal of such characteristics as tantalum possesses. Its resistance to reagents (excepting hydrofluoric, hydrofluoric and nitric acids combined, and hot caustics) places it in a class comparable with the noble metals in ability to withstand chemical attack. Aqua regia or chlorine, which readily attacks platinum or gold, has no effect on tantalum; and even pure hydrofluoric acid has only a very slow effect on pure tantalum. For this reason it is particularly adaptable to certain forms of laboratory apparatus.

Tantalum electrodes, dishes, spatulas and other forms have been produced, and are being used apparently with satisfactory results. Tantalum wire and sheet are readily available and can be turned to a variety of uses. Because it is less expensive than platinum, it bids fair to replace certain forms of laboratory apparatus. Tantalum cathodes are obtainable at about one-third the cost of platinum cathodes. When used as an anode, however, tantalum becomes covered with a layer of oxide, which acts as an insulator and obstructs the passage of the current, even though the voltage be raised; it cannot therefore be used satisfactorily for anodes in the ordinary way.

Metals such as silver, copper, platinum, zinc, nickel, and antimony can be deposited on a tantalum cathode and can then be redissolved from the cathode with acids or aqua regia without affecting the tantalum, which has an advantage over platinum for this purpose in that it forms no alloy with zinc at the surface of contact, and therefore does not require coating with copper or silver before use. It is also unattacked during the electrolysis of common salt, and can therefore be substituted for platinum in electrolytic bleaching apparatus.

Tantalum dishes have found favor because of the chemical properties of the metal. Substances such as platinum and gold can be dissolved with aqua regia in tantalum dishes without loss of weight from the vessel. The danger of oxidation is present if the metal is exposed to the open flame of a Bunsen burner or a burner of similar type, or if the dish is placed in an electric oven at a temperature higher than 400 deg. C. Incinerating or igniting dry solids should not be tried in tantalum dishes, nor the melting of metals. The use of tantalum, therefore, is limited to low temperatures and it cannot be considered as a substitute for platinum for high-temperature work. For surgical instruments, including hypodermic needles, the metal is admirable; the chemicals or antiseptics used in dentistry and surgery have no effect on it. Sterilization may be accomplished by immersion in alcohol or by placing in boiling water or sterilizing solutions.

Other industrial applications of tantalum are being investigated, and their adoption is merely a matter of applying in practice what has been demonstrated in laboratory tests. In radio devices, such as battery chargers, tantalum plays an important part because of a peculiar characteristic that permits direct current to pass through it in one direction only. It is used in tubes as a scavenger because of its great affinity for hydrogen. Stems, filaments, or other metallic parts usually contain hydrogen, which is liberated when the assembly is heated during processing. The tantalum absorbs the hydrogen and holds it tightly, no matter what temperature is obtained in the tube. This eliminates noises that are produced by gassy tubes.

Gases From Blasting Underground—A Study

IN CO-OPERATION with mining companies of the Southwest the U. S. Bureau of Mines is endeavoring to ascertain the safest and most economical explosives for use in metal mines and to determine the best methods of blasting under various conditions. One investigation has involved the comparison of the composition and quantity of the gaseous products of explosion of various explosives and the ascertaining of the effect of different methods of loading holes on the relative amounts of poisonous gases produced. The results of this investigation are embodied in Bulletin 287, entitled "Gases from Blasting in Tunnels and Metal Mine Drifts," by E. D. Gardner, S. P. Howell, and G. W. Jones.

The explosives commonly used for underground work are gelatin dynamite and ammonia dynamite, the authors explain at the outset. Because it produces large amounts of poisonous gases, "straight" dynamite is not used for blasting underground. A modified or so-called "black dope" straight dynamite, which does not make an excessive amount of poisonous gas, is used at a few places in the West.

Gelatin dynamite has a number of characteristics which make it desirable for underground work in metal mines and tunnels, and it is more commonly used for the purpose than any other explosive. Less poisonous gas is made by blasting with gelatin than with most of the ammonia dynamites on the market. Because of its plasticity and cohesiveness, gelatin dynamite is easier to tamp in drill holes than other explosives; this advantage is particularly evident in loading vertical stope holes on raise rounds. Moreover, gelatin dynamites have a high density that permits placing a larger proportion of the charge in the bottom of a drill hole. The natural insensitiveness to detonation of these dynamites is largely overcome by the use of strong detonators. Ammonia dynamite, as packed in cartridges, is often rather hard and consequently more difficult to tamp than gelatin dynamite; its lack of plasticity makes it less desirable for loading holes steeply inclined upward.

The gaseous products of explosion from dynamites are usually carbon dioxide, nitrogen, carbon monoxide, hydrogen, hydrocarbons of the methane group, and water vapor, although sulphur dioxide, hydrogen sulphide, and oxides of nitrogen may be formed, depending upon the composition of the explosive and conditions of blasting. Oxygen may be given off if there is an excess of this element in the explosive. Possibly ammonia, cyanogen, and other gases are given off occasionally under unusual conditions.

Field Test Data

A summary of the results of the investigation is given by the authors as follows:

When an explosive is properly detonated in inert country rock, the only toxic gas produced in dangerous quantities is carbon monoxide. Some sulphur dioxide and oxides of nitrogen were frequently produced under these conditions, but the quantities were harmless. Blasts in massive sulphides produced dangerous quantities of hydrogen sulphide and sulphur dioxide.

The investigation demonstrated that 40 per cent gelatin can be manufactured so as to evolve only small quantities of carbon monoxide in the gases from blasting. Less carbon monoxide is made by blasting with some gelatin dynamites than with others. The gases from blasting with two manufacturers' gelatins improved between the first and last tests. It is evident that the explosives companies are carrying on research work to improve their products in this regard.

The oxygen balance of the explosive appears to be of the most importance in the amount of carbon monoxide produced in the gases from blasting. The condition of the explosive may also affect the gases from blasting, as the insensitive explosive used in the Old Dominion tests gave more carbon monoxide than the same explosive in better physical condition used elsewhere. Here the No. 8 detonator did not suffice to overcome the natural insensitiveness of this gelatin dynamite. Gelatin dynamite that is too insensitive to detonation for efficient work should not be used.

The results of the sampling indicate that the gases produced by blasting are not always the same as those obtained in the Bichel gage.

Removal of the wrapper from the cartridges reduces the amount of carbon monoxide made in blasting, but with the samples employed it also cuts down the strength of the explosive.

It has been considered that oxides of nitrogen are likely to be formed by blasting with an explosive containing an excess of 5 or 6 per cent of oxygen. Two rounds were blasted during this investigation with two 40 per cent gelatins without wrappers, which had excesses of 3.7 and 5.3 per cent of oxygen, respectively; and the gases from blasting contained no more of the oxides of nitrogen than were found after the rounds that were blasted with the same gelatin containing a deficiency of oxygen.

Although the number of rounds that allowed comparison was limited, less carbon monoxide seems to be formed by blasting in wet ground than in dry rock.

The 30 per cent "black dope" dynamite produced the largest proportion and volume per cubic foot of carbon monoxide of all the explosives used at the United Verde Extension, and because of this unfavorable characteristic it should not be used in underground workings unless the ventilation is unusually good.

The 40 per cent "black dope" dynamite compares favorably with the 40 per cent gelatin dynamite that produced the largest carbon monoxide values, but, like this gelatin, should be used only in those workings in which the ventilation is good.

Although less toxic gases are made by some explosives than by others, the investigation demonstrates that with all the explosives tested efficient ventilation is required to remove the gases that follow blasting from mine workings before men return to work.

The field tests show that the composition of the gases from blasting the charges of the different holes of a round is not uniform. Study of the results does not indicate what physical conditions of the rock or of the manner of drilling the round cause the variations. However, there is no doubt that in hard rock the use of stemming reduces the amount of carbon monoxide in the gases from blasting. Stemming should be used in all holes, not only to reduce the quantity of poisonous gases from blasting but to increase the efficiency of the explosive.

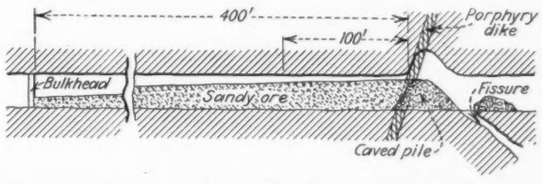
USEFUL OPERATING IDEAS

Handling Drainage Water

By Fred Johnson

AT THE Chief Consolidated mine, at Eureka, Utah, a water flow was struck 25 ft. below the 1,800 level and also at the 1,900 level. How to dispose of the water without pumping to the surface, 1,600 ft. above, was the question. On the 1,600 level, a 1,000-ft. drift extended north of any other working. There was caved ground near the end of the drift and a fractured zone extended downward. The pumping of the water into this fractured ground was suggested.

As an experiment to determine the porosity of the ground, an attempt was made to fill up a winze on the



Water discharge drift, 1,600 level, Chief No. 1 shaft

1,600 level by pumping. The winze drained off the water as fast as it could be pumped. It was then determined to use the drift as a drainage outlet. To further this purpose a bulkhead was constructed 400 ft. from the cave in the north drift and an 8-in. pipe laid to and connected to the bulkhead. Water to the amount of 500 g.p.m. was pumped to the bulkhead and discharged through the fissured ground. Subsequently two 12-in. pipe lines were added and water up to 3,000 g.p.m. was pumped to the fissured ground and disappeared.

After discontinuing mining below the water level, pumping was stopped, the bulkhead was opened, and it was found that a considerable accumulation of material had gathered in the drift back of the bulkhead. Assays were made upon the material, and as a result some 481 tons of ore averaging $7.65 per ton, or a total value of $3,681, was retrieved. This had been carried by the drainage water as fine sand, silt, and ore particles during the period when the drift was in use as a drainage outlet. The sketch shows the condition of the north drift end.

An attempt was made, before discontinuing mining, to determine whether any water was being returned by the fissure to the lower workings. About 100 lb. of fluorescein-sodium salt was added to the water, but no trace of it was detected in the drainage water.

At the Gemini mine a similar situation was encountered. Water was successfully pumped into a fissured zone. Tintic Standard was explored to a depth 400 ft. greater than the Chief Consolidated, but no water was encountered. The general structural situation of impervious zones between fissured zones, some water-bearing and others dry, is indicated.

Saving Space About a Plant

By William Crocker

CONSIDERABLE space is wasted in many plants by disorderly heaps of material, which spread out in every direction, blocking passageways and at times hampering operation. This same material can be so piled as to take less room. Observation will show that in general it is the long toes of these piles, containing only a little material, that occupy most of the space. By placing a few rocks, blocks, a timber or a plank at the foot of the pile, the space required may be decreased.

In general it pays to pile almost everything. The reason is that a pyramid or a cone, which is the shape assumed by most heaps, has only one-third of the volume that a prism or a cylinder of the same base and height will have. For example, more than three times as many brick or other similar material can be put on the same area up to the same height, if piled in orderly fashion, than if thrown in a loose heap.

Crusher Economically Repaired

WHEN faced with breakage in machinery, shop managers nowadays usually turn to welding as a means of averting delay. Where it is possible to weld the part, they know that it will go back to work fully as strong as it was before being broken, and production will continue with minimum delay. Such an incident occurred recently, says *Oxy-Acetylene Tips,* when the eccentric of a 42-in. gyratory crusher developed a crack which on inspection was found to be about 54 in. long and 3 in. deep. The crack was in the form of an L, extending to the smaller end.

The eccentric was removed and taken to the plant's central welding shop for more careful inspection. It was then seen that the large ring gear on the end of the eccentric would have to be removed if a new casting were ordered for replacement. This meant a great deal of work, because the gear was not only keyed on, but was also shrunk on the eccentric. Oxy-acetylene welding was suggested as the solution, since, besides the work of removing the gear and placing it on a new casting, there would be the usual delay in shipment, delivery, and erection if a new casting were ordered. As the casting was larger than any that had been handled previously in the plant welding shop, a service operator was called in to advise the plant operator in setting up and bronze-welding the job.

After the edges had been beveled properly, the actual work of welding was started, ordinary practices for bronze-welding being employed. In this weld 70 lb. of bronze welding rod was used. Welding required six hours. It was not necessary to preheat the casting to bronze-weld it. On a casting of this size avoidance of preheating represents a decided saving.

Identification System for Process Piping

WITH the support of the National Safety Council and the American Society of Mechanical Engineers, a complete systematic plan for piping identification has been issued by the American Engineering Standards Committee. Abstracts from the plan are given:

For quite a long time pipe lines in various industrial plants have been painted in different colors for the purpose of ready identification. Because the selection of colors has been arbitrary and influenced by local conditions, and because a comprehensive extension of such schemes soon involves a mass of detail which automatically renders them impracticable, the inadvisability of recommending any of them for adoption as a universal scheme is fairly obvious.

It is equally obvious that to attempt to outline a code in identification would result in a system that would automatically be rendered impossible in those industries which do not have a major group of colors allocated to its products. It is found, however, that any materials transported in pipes in a plant fall in one of the following classifications:

Safe Products—These products are those involving no hazard in their handling and no extraordinary high value. A workman will run no undue risks in breaking into a pipe bearing a safe material.

Dangerous Materials—These materials are those which are in themselves hazardous to life or property.

Protective Materials—Under this class fall materials which are piped through plants for the express purpose of being available to prevent or minimize the hazard of the dangerous materials above mentioned. These include, for example, ammonia for combating phosgene fumes.

Extra Valuable Materials—These might be classified with the safe materials, but where these products have a very high value it is preferable to give them a separate major classification.

Fire-Protection Equipment—This classification includes sprinkler systems and other fire-fighting equipment.

The standard scheme proposes the use of an identification mark made up of three distinct parts: (a) An identifying band of color or a solid color for the entire line which indicates to which of the main classifications the material belongs; (b) a stenciled legend, abbreviated or otherwise, placed on the color band and naming the material carried; and/or (c), where desired, additional colored stripes of contrasting hues at the edge of the color band. These identification marks shall be placed at intervals throughout the piping system to ensure ready identification during repair operations and in an emergency.

The colors allotted under (a) above are as follows:

Dangerous materials	Green or the achromatic colors, white, black, gray, or aluminum
Protective materials	Yellow or orange
Extra valuable materials	Bright blue
Fire-protection equipment	Deep purple
Safe products	Red

In any complete color scheme of this sort the natural basis is the solar spectrum and the spectral hues may be grouped in their natural order in the form of a circle. The illustration shows the arrangement of colors.

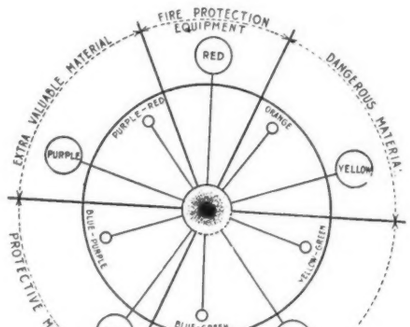
The committee suggests the following pigments for use:

No. 1: Toluidin Red—Fairly fast to aqueous acids, alkalis, and sulphur. Adds to the life of vehicles.

No. 2: Paranitranilin Red—Similar to the toluidin and cheaper, but has a slight solubility in the vehicle.

No. 3—A mixed pigment consisting of an organic red similar to toluidin mixed with zinc yellow. Fast to alkalis and sulphur but not to acids. Mixed with cadmium yellow in place of the zinc yellow it becomes fast to acids as well.

No. 4: Orange-Chrome Yellow—The regular color for ordinary use. Fast to alkalis but not to acids or sulphur.



Schematic diagram for the identification of colors

No. 5—Yellow ochre toned up with bright yellow. Where chrome yellows cannot be used this is a good low-priced pigment and is fast to everything.

No. 6: Cadmium Lithopone—A combination of cadmium sulphide and blanc fixe. Fast to everything, but the available supply is limited and the cost high.

No. 7: Chrome Yellow Lemon—For general use. Fast to acids but not to caustic alkali or sulphur.

No. 8—Chrome oxide toned up with a little yellow. A moderately low-priced oxide that is also fast to everything.

No. 9: Ordinary Chrome Green Light—Fast to weak acids but not to alkali or sulphur.

No. 10—Prussian blue tint with a base white of Titanox. Fast to acid, fairly resistant to sulphur, easily affected by alkali.

No. 11—Ultramarine blue tint with a base white of zinc oxide. Fast to alkalis and sulphur but not to acids.

No. 12—Base white of Titanox tinted with alizarine purple. Fast to everything.

For outside exposure linseed oil is the most durable vehicle. Where higher resistance to water is required and for interior use tung oil varnishes may be made use of.

In the matter of further and complete identification the committee finally arrived at the conclusion that such marking should consist principally of a lettered legend, abbreviated or otherwise, naming the material carried in the pipe line. The following letter sizes were adopted, the figures being in inches:

Outside Diameter of Pipe or Covering	Size of Stencil Letter	Outside Diameter of Pipe or Covering	Size of Stencil Letter
¾—1¼	½	6	1¼
1½—2	¾	7	2
2½—3	¾	8 —9	2½
3½—4	1½	10—11	3
4½—5	1½	12 and over	3½

DISCUSSION

On Precise Interpretation

THE EDITOR:

Sir—A statement in the article on "The Why of Flotation," which appeared in the Dec. 31, 1927, issue of *Engineering and Mining Journal,* is not correct. The statement reads:

"In cases of positive adsorption, there is ample evidence to show that at saturation, the adsorbed film is entirely made up of the dissolved substance. At concentrations less than saturation the adsorbed film is incomplete, but generally more nearly complete than *when* the solution is saturated. To illustrate: at a concentration one-half of saturation the relative density of the adsorbed film may be 0.95, considering a complete film as of relative density 1.0."

The word "when," introduced during editing, completely changes the meaning and makes this sentence contradictory to the one that follows. I would appreciate the publication of a correction in an early issue.

A. M. GAUDIN.

University of Utah,
Salt Lake City, Utah.

[The following alternative rendering of the middle sentence of the paragraph is suggested in an attempt at clarification: "The adsorbed film is incomplete at concentrations below saturation, but generally approaches completeness more nearly than does the saturation of the solution."—EDITOR]

Seattle Points the Way

THE EDITOR:

Sir—A mining institute, open to all men interested in any branch of the mining industry, will be held at the College of Mines, University of Washington, Seattle, during the week beginning March 5. Prospectors, miners, mine owners, persons interested in metallurgy, investors in mining enterprises, and the public generally are invited to attend. This institute will take the place of the Winter Mining Session which originated at Seattle in 1897 and continued for 28 years. The complete new equipment of mines laboratory will be used to give demonstrations of new machines and processes in mining, ore dressing, and metallurgy. This year the ceramic industry, including cement and branches of clay working of special importance in the Northwest, will be included in the institute. All instruction will be given by specialists.

Prominent technical men and managers will give lectures on their special subjects. Among the speakers engaged are: G. T. Jackson, formerly superintendent of the Alaska Gastineau and the Chichagoff mines, who will speak on the mining of large bodies of low-grade ore; R. F. McElvenny, A. S. & R., on the nature of contracts that a smelter can offer to mines and prospects; M. D. Leehey, mining lawyer, on some popular errors regarding the mining law; H. H. Townsend, on the exploration and purchase of prospects by operating companies; J. L. McAllen, on quartz mining in the Willow Creek district, Alaska; and F. Powell, on gold dredging. In the evenings, lectures illustrated by stereopticon views and moving pictures will be given. The week will close with an excursion to mines and plants.

MILNOR ROBERTS, Dean.
College of Mines,
University of Washington,
Seattle, Wash.

Mining Opportunities in Cornwall

THE EDITOR:

Sir—With reference to the available prospects for an investment in the tin-mining industry of this country, I have thought it possible that American capital might be interested to have particulars. In the numerous mines in this country that were closed about 60 years ago, no work has been done since except in a mine or two in the upper levels. Many of these properties were copper mines, producing tin associated with the copper or in a separate lode as well. Much of the tin found its way to the waste heaps, which have been worked over for 40 years, off and on, with good results.

It is supposed that the mines working principally for copper were closed down as a result of low price and the discovery of richer copper deposits elsewhere. The deepest mine in Cornwall would not exceed 2,000 ft. Doubtless there are considerable portions of orebodies left standing from the old developments. The mines could be put into production almost immediately as soon as unwatered. While this work was in progress, development would be proceeding.

Probably at no period in the history of tin mining has tin reached such a high price, and remained high. It is difficult to understand why the opportunity has not been taken to reopen these mines, in which only a portion of the mineral wealth has been extracted. The general opinion here is that many properties offer opportunity for an excellent investment. Reopening operactions have been started on a few mines by London syndicates.

To whom it may interest, I wish to say that I have nothing to offer on behalf of myself or anyone else, but that I shall be pleased to collect and give more definite particulars and answer inquiries of interested persons.

WILLIAM HOLMAN.

Blackwater, Truro,
Cornwall, England.

Fathers of Selective Flotation

THE EDITOR:

Sir—In the editorial "The Fathers of Selective Flotation" in your issue of Feb. 4 you give the names of several Broken Hill men to whom credit is due for the introduction and development of selective or differential flotation methods. It would seem that to your list should be added the names of T. M. Owen and Henry Lavers, both of whom were early in the field.

It is true, as stated in your article, that the Sunnyside Company, of Colorado, is generally credited with being the first to operate a commercial mill in North America that floated selectively two minerals from a complex ore, but before the practice was introduced at the Sunnyside mill there were two mills in British Columbia in which the flotation separation of galena (and silver minerals) from zinc blende was regular practice.

In the spring of 1914 at the mill of the Silverton Mines, Ltd., direct flotation of galena and free silver minerals was introduced, the blende being floated subsequently. Tables were relied on to recover the coarser galena. In trial work a concentrate high in lead had been obtained, but in practice, as I remember, the lead concentrate ran about 48 to 50 per cent lead. There was no re-treatment. Previous to the introduction of the practice, the zinc concentrate produced had been high in both silver and lead, but by selective floating the quantity of these metals in the zinc concentrate was so decreased as to make it readily salable.

At the mill of the Standard Silver Lead Mining Company slime and reground table tailing were treated by flotation. Toward the end of 1915 or early in 1916 the practice was introduced of floating a silver-lead concentrate prior to the flotation of the zinc. The lead concentrate, I am informed, ran only 12 to 13 per cent lead, but contained much slime gangue from the graphitic schist of the ore, which had,

previous to the introduction of the practice, prevented the making of a zinc concentrate of good grade.

JAMES WILDING.

New York City,
Feb. 18, 1928.

Professors and Engineers

THE EDITOR: In the main, I agree with Joseph P. Ruth, Jr., who writes in the issue of Jan. 28, but there is middle ground; for the veterans in the engineering profession know that the research and painstaking investigation of many of our professors point the way for further successful conclusions on many matters regarding which much uncertainty exists.

Who would undertake to question, for instance, the possible service to an operating copper company that my friend E. P. Mathewson, now at the University of Arizona, could render if he were called in consultation in a matter bearing directly on his specialty?

The neglect of college duties in order to take up private work is not to be condoned; but there are times and circumstances which make it highly desirable to have the advice that a technical, academic mind can give, and I believe that the public will continue to solicit and pay for the best brains that can be secured, no matter where tied up, in college or the broad operating field. I believe that many consulting mining engineers can bear witness with me that some of the most lucrative professional engagements have come to them by way of recommendation from brother engineers who are engaged in college work.

It all resolves itself into a proper regard for the rights of others; and it is my opinion that neither legislation nor the licensing of engineers will put ethics into the mind or heart of one who does not "give and take." F. L. SIZER.

San Francisco.

By the Way

One for the Book

WHETHER the East or the West is a better place for the incubation of ideas is open to question. However, Mr. Tom Stearns, of Denver, at a recent dinner in New York, launched one of the Western variety that has the merit of novelty to the *n*th degree. Mr. Stearns, to whom some other things are less agreeable than talking to an attentive audience, recited, first, how he and some of his associates, including the Harry Payne Whitney interests and the American Smelting & Refining Company, had revamped an old lead-silver property a couple of years ago with the expectation of making a fair profit. When they finally got the concentrator in operation lead was selling at better than 9c. per pound and silver at close to 70c. per ounce. The outlook was bright. But in a few months conditions changed for the worse. Silver declined gradually to 55c. and lead to 6.25c. Profitable operation was impossible. "Now," quoth Mr. Stearns, "I want to propose a project that offers the American Institute of Mining and Metallurgical Engineers, or the Mining and Metallurgical Society of America, or the American Mining Congress, or any other organization that will put it over in good order, an opportunity to make itself solid with the entire mining industry, for all time to come. My proposal is that a standing committee be formed within one of these organizations (I play no favorites, and the idea is open to any of them) with one simple little function—namely, to guarantee the stability of the price of all these nonferrous metals, so that when a company opens up a new mine it can go ahead with the assurance that profits will not be shot out from under it by a drop in the price of the metals it produces." Cheers, and more cheers!

The Mispronunciation of Data

APROPOS of the controversy concerning the singular and plural usage of "data" attention may be called to the fact that this word is mispronounced much more commonly and with less justification than it is incorrectly used in writing, states R. H. Smith in *Science*. Probably no other word in the vocabulary of the average scientist is mispronounced more generally. Merely as an example of this fact, the incident mentioned below is noted from the last annual meeting of the Pacific Division of the American Association for the Advancement of Science. The pronunciations "dāta" and "dăta" were used by two different persons on the program at one of the general meetings. In a meeting of the section on entomology one speaker pronounced the word "dāta" another pronounced it "dăta" and a third "dāta." The leading dictionaries, including Funk and Wagnalls' New Standard and Webster's New International, give only one pronunciation—dāta.

In some respects, Mr. Smith avers, this matter may seem too trivial to be mentioned. However, the student in high school, college, and university, and Mr. Average Citizen have come to regard the scientist as one who is peculiarly exact and correct, and this ideal is not enhanced when scientists are careless.

The Bureau of Mines Passes the Buck

FROM a recent morning's mail. "*Engineering and Mining Journal-Press,* New York. Please send me Methods for Discovery of useful Mineral Deposits. Inclosed find stamp for reply. G. W. H.

"P. S. The Bureau of Mines, Washing, D. C., gave me your Adress."

Consultation

Tungsten and Molybdenum Producers

"We wish the addresses of the different companies operating in tungsten and molybdenum."

Available office records indicate the following companies operating tungsten properties:

Atolia Mining Company, 1022 Crocker Building, San Francisco, Calif.
Tungsten Products Company, Bishop, Calif.
Tungsten Production Company, Boulder, Colo.
Wolf Tongue Mining Company, Oliver Building, Pittsburgh, Pa.
Nevada-Massachusetts Company, Sonora, Calif.
Osage Mining Company, Rochester, Nev.
General Tungsten Corporation, Goldfield, Nev.
Western Exploration & Mining Company, First National Bank Building, Denver, Colo.
Red Top Mining Company, Stevens County, Wash.
Lezeart Syndicate, Evanston, Wyo.

The following molybdenum operators are recorded:

Climax Molybdenum Company, 61 Broadway, New York, N. Y.
Molybdenum Corporation of America, Empire Building, Pittsburgh, Pa.

Our readers are invited to contribute amplifications, additions, or corrections.

Copper-Leaching Plants

"Will you please tell me what companies in North and South America are making cathode copper (excluding blister copper refineries) and the approximate monthly production of each."

You wish, in other words, to know what plants are leaching copper ores, with electrolytic precipitation of the dissolved copper. There are only three such plants: Chile Copper Company, with a present monthly production of about 9,000 tons of cathode copper; Inspiration Consolidated Copper Company, probably producing about 1,900 tons per month from its electrolytic plant; and New Cornelia, estimated to be turning out about 600 tons of cathode copper per month. Other leaching operations include those of the Kennecott and Calumet & Hecla, at which ammonium carbonate is used for dissolving the copper, which is subsequently precipitated as oxide by volatilization of the ammonia; the Ohio Copper Company, the Nevada Bellevue Copper Company, and the Cananea Consolidated Copper Company, where weak sulphuric acid is applied to the ore in the mine, and copper precipitated from the solution on scrap iron; and the Phelps Dodge Corporation, which produces a small amount of cement copper from scrap iron precipitation following heap leaching. Anaconda and Nevada Consolidated have also carried on some work on leaching old tailing piles with acid.

INDUSTRIAL PROGRESS

An Improvement in Bronze-Welding Cast-Iron Pipe

AN INVESTIGATION of the proper methods of laying bronze-welded cast-iron pipe with the collar-type joint was made during 1927. In the course of this investigation, which was conducted jointly by engineers of the Linde Air Products Company and the United States Cast Iron Pipe & Foundry Company, it became evident that the collar type of joint had certain defects. Since a strong leak-proof joint for cast-iron pipe is an important problem in some industries, it seemed desirable to review the entire question of the design of joint for bronze welding of cast-iron pipe.

In the early stages of the development of bronze welding several types of joint design were investigated—namely, the vee, collar, and combined vee and collar. Tests made on strips cut from the pipe showed that failure occurred in the cast iron adjacent to the bronze for all cases of collar type design, whereas the simple vee type failed along the bevel. Since the collar design took advantage of the well-known high shear strength of bronze adhering to cast iron, and furthermore since all of the breaks with the collar type occurred in the pipe itself, it was decided that the collar was the correct design, and this type has been used almost exclusively in all installations.

This investigation and tests of bronze-welded joints in full-size members have established the following facts:

1. The bronze welded collar joint for cast-iron pipe is inefficient.

2. The weakness of the joint and the characteristic failure that occurs in the cast iron next to the bronze collar is not due to shrinkage of the bronze collar, structural change, or any detrimental effect on the cast iron from heat or the bronze-welding process. The weakness is in mechanical design and is the result of a very high stress concentration adjacent to the collar.

3. The bronze-welded vee joint is from 50 per cent to 100 per cent stronger than the collar joint. The strength of the vee joint, although not exactly equal to that of the pipe, approximates it. Searing or annealing the machined bevel is necessary to insure a strong positive union between the bronze and cast iron.

4. The shear-vee joint by adding a shear area to the strong vee joint develops practically the full strength of the pipe.

5. The vee-type joints, in addition to being stronger, require less materials, are more easily and quickly made, and are hence cheaper than is the collar joint. They compare favorably in cost with any of the common mechanical joints in use which do not have the absolutely leak-proof, non-deteriorating qualities offered by the bronze welded joint for cast-iron pipe.

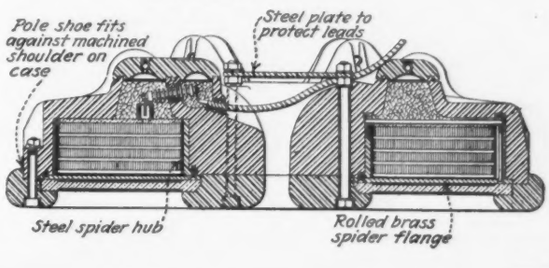
6. Under ordinary conditions, the use of these joints, combined with reasonable care and thought in laying and placing expansion joints, guarantees the elimination of failures in a bronze-welded cast-iron pipe line.

Lifting Magnet Redesigned

WHERE hot ingots have to be moved, the lifting magnet finds an important application. A magnet of this type in which important improvements have been made has recently been introduced by the Electric Controller & Manufacturing Company, Cleveland. By reason of the changes in design, it will outlift and outlast earlier types, according to the maker. Some of its features are indicated in the accompanying illustration.

The new magnet is provided with an extremely heavy coil, necessitating a coil spider of increased strength. For this reason the spider, which formerly was a 1-in. brass casting, is now made in two pieces. The lower flange is of heavy rolled brass plate to which is bolted a cast-steel hub, accurately machined to fit around the central pole. This hub adds useful metal to the magnetic surface and contributes to the increased lifting capacity. The outer pole shoe is extended outside of the magnetic base, bearing against a machined surface, thus giving protection against breakage of the pole shoe.

The terminal leads, where they emerge from the terminal housings, are protected against the crushing effect of the chain supports and the crane hook by a heavy steel plate carried by the center pole bolts.


Pole shoe fits against machined shoulder on case
Steel plate to protect leads
Steel spider hub
Rolled brass spider flange

An improved magnet for lifting hot iron

BULLETINS

BEARINGS—Timken Roller Bearing Company, Canton, Ohio. "The Truth About Anti-Friction Bearings." Sixteen pages.

RESISTORS—Monitor Controller Company, Gay and Frederick Sts., Baltimore, Md. Bulletin 111. Monitor resistors. Eight pages.

MAGNETIC PULLEYS—Cutler-Hammer Manufacturing Company, Milwaukee, Wis. Bulletin P-26, entitled "Magnetic Protection." Fourteen pages.

FLOOD LIGHTS—Crouse-Hinds Company, Syracuse, N. Y. Bulletin 2105, entitled "Floodlighting and Aid to Guards."

PIPE CONNECTIONS — Crouse-Hinds Company, Syracuse, N. Y. Bulletin 2107, entitled "Pipe Hangers, Fixture Hangers, Unions and Connectors." Eight pages.

FORCED DRAFT BLOWER — Bayley, Blower Company, 732 Greenbush St., Milwaukee., Wis. Catalog No. 32, covering Aerovane blowers. Thirty-four pages.

COKE—International Combustion Engineering Corporation, New York Catalog DQ-2 covering the Sulzer system for dry quenching coke. Thirty pages.

ELECTRICAL SUPPLIES—Westinghouse Electrical and Manufacturing Company has issued its large "Catalog of Electrical Supplies, 1928-1930," containing 1171 pages.

REDUCERS—Bulletin A of the Albaugh-Dover Manufacturing Company, 2100 Marshall Boulevard, Chicago, is devoted to speed reducers. It contains 18 pages.

BLOWER—Bulletin 3504 of the American Blower Company, Detroit, covers the Type SE steel plate blower. It comprises 15 pages.

SOOT BLOWERS — National Flue Cleaner Company, Groveville, N. J., describes the National soot blower for return tubular boilers in a 6-page folder.

WELDING—General Electric bulletin GEA-875A covers the type WD-300A arc welder.

NEWS OF THE WEEK

Summary

U. S. COURT OF APPEALS reverses the decision of Justice Bourquin in the case of Carson Investment vs. Anaconda Copper, stating that he erred in not considering A. S. & R. decree final.

* * *

Two recent decisions involving flotation patents are of importance in flotation history. A comprehensive summary of the two cases, the companies, patents, and principles involved will be found on page 388.

* * *

Canadian legislature makes reductions in tariff on mining machinery and supplies imported into the dominion.

* * *

Tin situation becomes serious in London as the price continues to fall. Nigerian producers are hardest hit.

* * *

Consolidation of Evans Lead and Golden Rod Mining unites important lead and zinc mining and manufacturing interests. Edgar Wallower heads new concern, to be known as the Evans-Wallower Lead Company.

* * *

Tonopah gold production is on the increase. Strike at Forty Mile Canyon, in Nevada, precipitates a mild flurry.

* * *

Sherritt Gordon, one of northern Manitoba's most promising properties, is being rapidly developed. Machinery is being transported from The Pas to aid in the sinking of two shafts.

* * *

American Metal acquires famous Presidio mine, which has produced $22,000,000 of silver as well as quantities of lead and gold.

* * *

Foremen in the Tri-State district organize for the purpose of safety work. About 70 of these men, who, it is estimated, supervise the work of 7,000 miners and the production of half the country's zinc, attended a meeting in Miami recently. See pages 386 and 387.

Senate Mines Committee Inquires Into Appropriation Cut

Director Turner of the Bureau Is Questioned on Reduction of 50 Per Cent of Funds for Mineral Survey

By Paul Wooton
Special Washington Correspondent

REDUCTION by more than 50 per cent in the appropriation requested by the departments of War, Navy, and Commerce, and by the A.I.M.E. for a world survey of mineral resources has been inquired into searchingly by the Senate Committee on Mines and Mining. An extract from the stenographic record of the examination of Director Turner, of the U. S. Bureau of Mines, by members of the Mines and Mining Committee, follows:

Senator Oddie—Mr. Turner, you referred to letters that the Secretary of Commerce, the Secretary of War and the Secretary of the Navy had written the Director of the Budget. What was the effect of those letters on General Lord's action?

Mr. Turner — The Bureau of the Budget cut it to $50,000. The Appropriations Committee of the House cut it to $25,000. The Senate Committee on Appropriations restored it to $50,000. In conference they agreed on $35,000.

Senator Oddie — Who in the Budget Bureau handles such items?

Mr. Turner — The Department of Commerce items are handled by one committee.

Senator Oddie — Are there engineers or economists on that committee?

Mr. Turner—I do not know as to the training of the men on the committee, although I feel sure there are no mining men or engineers on it.

Senator Oddie — Do you think the question of dollars and cents supersedes that of service?

Mr. Turner—On account of the huge volume of business going through the fiscal agents I imagine the amount of money involved must be looked at more particularly than that which is to be accomplished by the expenditure of the money.

Senator Oddie — In other words, the question of the expenditure of a certain amount of money is paramount. The question of the service necessary to the industries and to the defense of our country is secondary.

Mr. Turner — You are getting into pretty deep water for me.

Senator Pittman—How many casualties were there last year from mine accidents?

Mr. Turner — Deaths in mines amounted to about 2,500. Casualties would run into the millions.

Senator Pittman — I assume that the degree of the casualties will be in proportion to those resulting in death. Assuming that 2,500 soldiers are killed in battle, the proportion of wounded would be very much greater. Your preliminary estimate for investigating mine accidents was $566,470. After talking with some one in the Department of Commerce about the matter you reduced it to $500,470. Then I find that the estimate authorized by the Department was $399,470. They finally authorized a request in the amount that the Budget insisted upon.

Mr. Turner—The Department is informed by the Bureau of the Budget as to the total amount it may have to distribute among its bureaus.

Senator Pittman—Do you think that by the work you have outlined you can bring about a reduction in the percentage of casualties from mine accidents?

Mr. Turner—Any estimate would be open to criticism, but I can give you a concrete case. Last year Congress gave us $7,500 to investigate falls of slate or of roof in coal mines. We got the State of West Virginia to co-operate with us. The state gave us $4,000 and assigned men to work with us. We picked an area in West Virginia and put on a two months' intensive campaign there, with the volunteer help that we could get. The figures for deaths from falls of roof and coal, which is responsible for one-half the deaths underground, were cut in two.

Senator Oddie — In that area, then, deaths were reduced from 70 to 35.

Senator Pittman — If you could perform that same work in all the coal mines there would be a large saving of lives.

Mr. Turner—Yes.

Senator Pittman—The reason you are not able to extend it over the whole

country is because you do not have the money to send out the men?

Mr. Turner—Exactly.

Senator Oddie—If that same ratio were carried out among all the coal mines it would result in a saving of 600 lives a year.

Senator Pittman — This situation demonstrates very clearly what you gentlemen are up against. I do not think it is your fault at all. I imagine it may be the fault of some of us here in Congress. The very idea of cutting off $100,000 in that item which involves the lives of several hundred men. I cannot conceive of it.

Claim Owners Win in Suit Over Timber Rights

A CASE involving the right of owners of mining claims within national forests to all the timber within the boundaries of their claims was recently decided in favor of the owners by Judge C. C. Cavanah, of the U. S. district court for Idaho. Jack Waite Mining had made a contract with the forest service for the purchase of 500,000 ft. of timber near property in the Coeur d'Alene national forest. It happened that part of this timber stood on ground owned by Dan Deasy and other local mining men. The latter obtained an order from the state court restraining Jack Waite Mining from cutting the timber. Thereupon representatives of the forest service applied to Judge Cavanah for an order restraining the claim owners from interfering. It was asserted in the complaint that the mining claims were not valid locations. The court, however, found that they were located and held in conformity with the mining laws of the United States. Judge Cavanah denied the petition for the restraining order.

Carson Wins Appeal Against Anaconda

THE U. S. Circuit Court of Appeals at San Francisco has remanded to the Montana court the case of the Carson Investment Company, plaintiff and appellant, vs. the Anaconda Copper Mining Company, defendant and appellee. In its decision the court held that Justice Bourquin erred when he refused to permit Carson to introduce evidence to prove that Anaconda was a party to the American Smelting & Refining Company case and as such was bound by the decrees in that case. According to the decision, the decree in the A. S. & R. case was final as to the validity of the Carson patents. A review of the issues involved will be found in *Engineering and Mining Journal* of Dec. 3, 1927. The text of the decision will appear in a forthcoming issue.

Lower California Resources to Be Studied

A commission was recently appointed by the department of Commerce, Industry and Labor of the Mexican government to study the mineral resources of Lower California. Known minerals on the peninsula already include gold, silver, copper, zinc, iron, rock salt, onyx, opals, and turquoise.

Mexico Has More Than Five Hundred Active Mines

ACCORDING to a statement just issued by the department in charge of mining affairs of the Mexican government, there were 525 mining properties in Mexico actively engaged at the close of 1927. An almost equal number was described as idle; and quite a few were given as "unclassified," whatever that may mean. Since the first of the year a number of properties on the idle list have been reopened. Preparations are being made to resume activities on a number of others. At the same time, no petitions for permission to shut down have been made recently.

Montana Section of A.I.M.E. Holds Annual Meeting

CHAUNCEY L. BERRIEN, superintendent of mines for Anaconda Copper, was elected chairman at the annual meeting of the Montana Section of the A.I.M.E. recently. Dr. F. A. Thomson, dean of the school of mines, University of Idaho, addressed the section on "The Geology of Idaho." The meeting was held at the Silver Bow Club, Butte, Mont. Other officers elected were: W. N. Rossberg, vice-chairman; Alexander McDonald, secretary-treasurer; and E. A. Barnard and A. E. Adami, members of the executive committee.

Changes in Faculty at Michigan College of Mining

The board of control of the Michigan College of Mining and Technology at Houghton has elected Dr. C. O. Swanson, of Canada, professor of geology at the institution. He is a graduate of British Columbia University and received his master's degree from the University of Wisconsin. He has had wide experience in geological work. R. R. Seeber, who has been a member of the college faculty for a number of years, was made professor of mechanical engineering to succeed George L. Christensen, resigned.

"Air Blasts" at Keweenaw Have Subsided

Mohawk Continues Record Production —Study of Milling to Be Made

THE SERIES of so-called "air blasts," or earth shocks, which have been felt on the Keweenaw peninsula during the last few weeks, appear to have subsided. An examination of the Quincy shafts, where the shocks centered, revealed no damage, and the active workings of the property likewise are intact. No. 6 shaft, the only one now producing, has been timbered to the 87 or bottom level and crosscutting to the Pewabic bed will be started shortly. Good headway is being made with retimbering in No. 2, the repair of which will permit resumption of development in the rich new East lode as well as in the main Pewabic vein. Persistence at depth of heavy mineralization in the East lode adds greatly to Quincy's copper reserves and apparently assures its future as one of the district's reliable producers. The damage in No. 2, caused by the fire of last year, is extensive, but the copper showing at depth fully warrants the rebuilding of the shaft through the burned area. Installation of the new boiler plant at No. 6 shaft is resulting in a notable saving. In January this saving in coal, labor and supplies was more than $4,000.

Further attention is to be given to the problem of saving a greater per cent of the values in the milling of the rock of the Michigan copper district. Notable progress has been made in this direction, through improved table treatment and use of regrinding units, but copper losses per ton of rock still total about 5 lb. for amygdaloid rock. To reduce this loss, the U. S. Bureau of Mines will co-operate with the Michigan College of Mining and Technology at Houghton and the mining companies of the district. Arthur W. Fahrenwald, the Burerau's leading expert in ore dressing, who has been successful in this line of work in Idaho, will make an exhaustive study of the Michigan milling practice, which will require two years time or longer.

Arcadian Consolidated's New Baltic shaft has been sunk 140 ft. from the 1,250 level. The shaft will be lowered at least 200 ft. more before any further drifting is done. New Arcadian vein, in which good values were found in the upper levels, probably will be opened first, after which a lode as yet unidentified, which was cut at the 1,250 level and found quite heavy in copper, will be investigated.

Mohawk is maintaining the rate of production which gave the mine a record output of copper in 1927. No. 5 shaft will probably be reopened this year to reclaim the stamp rock left in drifts and pillars. None of the Mohawk shafts are mined out as opening work progresses.

Glenallen Mining Wins Suit From Park Eastern

Judge G. S. Barker has allowed the claim of the Glenallen Mining Company that its properties in the Park City, Utah, district had been obtained by Park Eastern Mining through an act of bad faith on the part of Joseph H. Marshall, who obtained bond and lease on the properties and then transferred them to Park Eastern.

Seventy foremen of the Tri-State district

Golden Rod and Evans Lead Are Merged

New Lead-Zinc Concern, to Be Known as Evans-Wallower, Combines Both Mining and Manufacturing

GOLDEN ROD Mining & Smelting, of Joplin, Mo., and Evans Lead, of Charleston, W. Va., have consolidated to form a single company, known as the Evans-Wallower Lead Company. This move combines one of the leading producers of lead and zinc in the Tri-State field with a prominent manufacturing concern engaged in the production of litharge, a monoxide of lead and red lead. Edgar Wallower, of Joplin, is the president of the new company.

Golden Rod has been prominent in the Tri-State field for the past decade. Last year it stood second as a producer of lead and third as a producer of zinc among the operators in the Joplin-Miami district. The mines are in Kansas and Oklahoma.

Evans Lead was organized by the late Marshall Evans, formerly of Eagle-Picher. Litharge enters into the manufacture of lead cell batteries, paint, enamel, oil refining, linoleum, rubber, and tile.

Assets of the new company will be close to $4,000,000, with its affairs in a strong financial condition from the outset, according to President Wallower. Current assets are approximately $935,361, against liabilities totaling $141,842, with no bonds or fixed liabilities outstanding.

Outstanding issues of the new company will consist of 12,500 shares of first-preferred 7 per cent stock of $100 par value, and 450,000 shares of no-par-value common stock. New stock has been apportioned among stockholders of the two companies according to valuations made by engineers who examined the properties.

Officers of the new company, in addition to Edgar Wallower, are: F. C. Wallower, Joplin; Ray Evans, Charleston; H. H. Wallower, Leadville, Colo.; and W. H. Rowley, Charleston, vice-presidents; H. C. Mills, Joplin, secretary; and Louis M. Atha, Charleston, treasurer.

Canada Reduces Tariff on Mining Machinery and Supplies

Xanthate, Cresylic Acid, and Blowers for Flotation Machines Now on Free List

CANADA'S 1927 Budget was presented in the Dominion House on Feb. 16, and it includes a number of changes affecting the mining industry. All changes became effective Feb. 17. Income tax on corporations has been reduced from 9 to 8 per cent and the sales tax has been reduced from 4 to 3 per cent. A number of tariff changes were made affecting machinery and supplies used in mining. Xanthates and cresylic acid and compounds of cresylic acid, for use in concentration of ore, were placed on the free list. Formerly they paid a duty of 17½ per cent. Locomotives adapted for use in underground haulage have been reduced from 35 to 20 per cent. Machinery for the concentration of ores has been reduced from 27½ to 20 per cent and hoists of a size larger than made in Canada have been reduced from 27½ to 20 per cent. Tariff item No. 462 covers a number of articles used particularly in the smelting of ores. In the old tariff these items were free, but the tariff did not make provision for integral parts, which had to pay a duty of 27½ per cent. In the new tariff integral parts will now be free and the item also makes provision for the free entry of blowers for use in connection with flotation machines.

Tri-State Foremen Organize for Safety Work

GRADUALLY the importance of effective accident prevention, not only from the humane but also from the economic standpoint, is being realized. In the Tri-State district, for instance, a meeting of the foremen of 23 different companies engaged in operations there was recently held at Miami, Okla. This meeting was not a single spasmodic attempt, but the first of a series of such meetings to be held monthly.

The accompanying illustration shows the 70 foremen who were present. It has been estimated that these 70 men supervise the production of more than half the zinc annually extracted in the United States. Since the welfare and the safety of the 7,000 men under their supervision rests largely upon their ability, the necessity for adequately training these foremen in the essential safety precautions is easily realized.

At the first meeting, the speakers included A. T. St. Clair, of Federal Mining & Smelting; Riley Clark, mine inspector for the fourth Oklahoma district; and Dr. F. V. Meriwether, chief surgeon of the U. S. Bureau of Mines. After a while it is planned to turn the meeting over to the foremen themselves, in the belief that discussion of the problems by them should serve to clarify any difficulties that may arise in the course of practical operations.

National Tin Developing South Dakota Deposits

National Tin, a New York company, is actively engaged in the exploitation of tin and gold deposits in the Black Hills of South Dakota. Gold Mint, one of its properties, has just completed a ten-stamp gold-ore mill, which will be in operation soon. Gold Mint is situated two miles from Hill City, S. D.

at a recent safety meeting in Miami

American Metal Takes Over Presidio Silver Mine

AFTER owning and operating continuously for more than 40 years the Presidio silver mine, at Shafter, the Presidio Mining Company, which has its headquarters in Los Angeles, has sold the property to American Metal. The consideration was not made public, but it is known to be several million dollars.

Presidio mine has a record of having produced more than $22,000,000 worth of silver. It was taken over by American Metal under lease with option to purchase in April, 1926. During the last twelve months the ore reduction mill at the mine has treated approximately 5,000 tons of ore a month, and in the last ten months of 1927 a total of approximately 1,000,000 oz. of silver, a large amount of lead, and some gold were produced. One of the original stockholders of the Presidio Mining Company was the late General W. H. Shafter, of the United States Army. It was a productive and profitable producer of rich ore from the grassroots down to the present lower levels. In this connection, it is stated that American Metal during the period that it has been operating the mine under lease uncovered a new orebody with good mineralization in one of the lower levels.

Additional machinery and equipment will be installed. Included in the transaction is a tract of about 1,200 acres of mineral land upon which the mine is situated. Outcroppings of veins of silver ore have been found upon the land which the company plans to develop.

The concentrates from the reduction mill are shipped to the smelter at El Paso, Tex., and the cyanide precipitates are shipped to the Shelby plant, at San Francisco. It is planned to organize a subsidiary company to operate the mine and mill.

Presidio is situated 45 miles from the nearest railroad point on the Southern Pacific. The surveyed route, however, of the proposed extension of the Kansas City, Mexico & Orient Railroad from Alpine to Presidio is via Shafter. It is expected that this road will be constructed during the next year or so.

Sherritt-Gordon Fulfilling Expectations

Property in Northern Manitoba Shows Large Deposits of Zinc and Copper

REPORTS from the Sherritt-Gordon property, in The Pas district of Manitoba, indicate that it is fulfilling the expectations of its backers. A vein, 12,000 ft. in length, 8,000 of which is ore, has been proven, according to these reports. The average width is put at 17 ft. Eighty men are employed in development on the property. Two shafts have been started 7,000 ft. apart. Plans call for sinking of both to 500 ft. Four diamond drills are being employed to prove further intersections of ore. Equipment for shaft-sinking is being brought to the property from The Pas by nearly 100 teams and several tractors. It includes three Diesel engines, two of which are to be used for the shafts. In the meanwhile hand steel is being used, and by the time the machinery can be installed the shafts should be deep enough to permit the erection of headframes. It is hoped that the work of transportation will be completed before the spring thaw sets in.

Diamond drilling is being continued near the middle of the vein, where a gap of 2,000 ft. occurs. Copper and zinc are the predominating metals in the ore, although there are also small quantities of gold and silver. The east end has so far proved to be of higher grade, two trenches having shown widths of 45 and 79 ft.

Several Plants Being Built in Coeur d'Alenes

Low Prices for Lead and Zinc Fail to Discourage Idaho Miners

ALTHOUGH the advance in metal prices, which was hoped for following the first of the year, has not materialized, and though, in fact, an actual decline in prices has occurred, lead and zinc production in the Coeur d'Alene district, Idaho, is being maintained on a normal basis. Several companies have new plants either under construction or consideration, new mines are preparing for production, and development work in various parts of the district continues.

Extremely cold weather has held up operations at the new mill of Cedar Creek Mining & Development, which was recently completed. The company intends to start production by April 1. Ore to be treated is lead-silver and zinc. Capacity of the mill is 100 tons.

Dickens Consolidated is continuing the development of its properties in order to have large quantities of ore available before starting the construction of a 200-ton flotation mill.

Golconda Lead, another Idaho company, has also started construction of a new mill. According to William A. Beaudry, manager of the company, it will cost about $80,000 and should be erected in 100 days. Thirty-six men are engaged in the work.

Sherman Lead, which has been dedeveloping its properties for several years, has reached the production stage. The ore is silver-lead-zinc. Shipments are expected to average 100 tons daily. Control of Sherman Lead is held by the Day brothers, who also have extensive holdings in the Hercules property. In fact, Sherman Lead has made arrangements for the use of the Hercules tunnel outlet to the railroad, as well as for the Hercules mine plant.

Another Chapter Added to History of Flotation Litigation

By Homar L. Johnson
Editorial Staff

THE WEEK of Jan. 29-Feb. 4 marks the addition of another chapter to the eventful history of flotation litigation. Two events of major significance occurred. On Jan. 31 Justice Bourquin made a decision, in the U. S. district court of Montana, favoring the defendant in the Metals Recovery *vs.* Anaconda Copper patent-infringement suit. Plaintiff alleged that the Minerals Separation process in use by Anaconda infringed the Perkins patent, control of which is held by Metals Recovery, allied with General Engineering, pioneers in the pneumatic-flotation field. The second event was the decree in the Minerals Separation *vs.* Magma Copper infringement suit, dated Feb. 3, in favor of the plaintiff. The patent involved in this case is the so-called second basic patent of Minerals Separation, relating to the use of soluble frothing agents, which patent expired in June, 1927.

To analyze these decisions with some degree of chronological consistency it is necessary to reverse the order in which they were handed down, and to consider the last one first. So rapidly has progress been made in the practice of the art of flotation during the last five years that many who are now interested in the subject will not recall the general conditions that existed at the time and that were largely responsible for the launching of the Minerals Separation vs. Magma infringement suit. Minerals Separation had, more or less, established its control of the basic patents in the art, largely through success in earlier lawsuits. Its straight mechanical-type cell had not been superseded by the subaëration type to the extent obtaining at present. The legal position of the pneumatic-type cell, featured by the Callow interests, or General Engineering, had not been decided. Users of the pneumatic cell, in general, refused to accede to Minerals Separation's demands for recognition of their patents. Although previous litigation had been carried on some years before, between the mechanical-cell and pneumatic-cell proponents, chiefly in the Miami case, the issue was not clearly defined. It was generally considered that, if Magma practice infringed the M. S. patents, there was little hope of evading payment of royalty to this company. Hence the outcome of the Magma suit was expected to yield definite information to all users of flotation, even though the case might be carried to higher courts before the final decision was reached.

This was the situation when the case came before the district court of the United States, southern division of the district of Maine, at Bangor, late in June, 1923. Hearing was completed early in July. There was nothing in the court record to indicate other than an early decision. However, as the months passed, and the justice with whom the decision rested attended to his other duties, all hopes for a timely settlement were dissipated. Months rolled by, then years, and the continued silence, if not golden, was at least complete. The result hoped for—speedy settlement, to assure progress in research and application in the field—was the antithesis of the chaotic condition that resulted. Finally, operators became disgusted; and, as Minerals Separation announced reduced royalty rates, they gradually joined the ranks of the licensees. Minerals Separation claims that all but Magma and one other user of flotation had capitulated at the time the patent expired.

Thus we come, at last, to the decision itself. In view of the time required to complete and perfect the opinion of the Court, nothing less than a masterpiece was expected, but the achievement would hardly be recognized by an identification based on such expectations. After four and one-half years, a decision is handed down based largely on precedent. In addition to being belated in appearance, it is weak in one or two vital points and, to say the least, of uncertain logic in several others. The gist of the decision is the belief that the whole case has been occasioned by differences of opinion or viewpoint. It becomes the duty of the Court, therefore, to decide which of the two viewpoints is correct, or to select a middle ground that permits a tenable viewpoint.

Adsorption was a relatively new explanation, advanced by the defense, for the flotative qualities of X-cake in the alkaline flotation circuit and Callow cells at Magma. The Court holds this explanation to be untenable, in view of the testimony offered. It is of interest to note that recent progress in scientific research on the underlying fundamentals of flotation tends to substantiate the adsorption theory.

The Court dismisses the argument of the defense—as to the too-broad scope of the second basic patent (the one under consideration)—largely on precedent. To quote: "It would be unseemly not to follow a decision which is entitled to the greatest respect . . . determining the title to the same property"; which quotation is itself part of the decree. The claim of the defense, that alkalinity of pulp in the operation at their treatment plant does not fall within the claims of the patent, is decided as follows: "Even if the patentees did not know that the process described by them could be carried on with an alkaline pulp they did not limit themselves in that respect, and it is sufficient if the real novelty of their invention is broad enough to support the claims, as it appears to be"; and "So claims 1 and 2 here, not being limited to acid processes, being valid, are infringed by the defendant's alkaline process"; and also that the point was covered by a prior decision.

The remaining defense, that "the claims are not infringed by the defendant's process, because the claims were deliberately limited by the patentees to the agitation-froth process, i.e., a process in which the froth is formed by agitation, and the defendant uses the pneumatic-flotation process in which the froth is not formed by agitation," is also refused by the Court. It is maintained that the introduction of air under pressure into an ore pulp does result in agitation of the pulp, although the resulting bubbles are of different character and the violence of the agitation is less marked. In other words, that agitation may be produced either by "stirring with a paddle" or "introducing air under pressure"; and "As was said by Professor Taggart, expert witness for defendant, in an article he wrote on the subject before he was connected with the case, 'the only difference is in the method of introducing air.'"

Usually the best time to ask questions of a litigant concerning his position is after the decision is handed down. In this instance, however, the parties concerned maintain a nothing-to-say attitude. An opinion is widely held, however, that the conduct of the Court in withholding the decision of what was meant to be a test case until after the patent in question had expired may be adversely criticized. Litigation is always an expensive procedure, and, generally speaking, is warranted only by the expectation of a subsequent monetary or "spiritual" reward, in comparison with which the litigation expense will appear as trivial. The contention of the Court that the suit was necessary to decide the correctness of two different viewpoints of the same subject is axiomatic. "Get the other man's viewpoint" is an excellent slogan. In any event, it is thus that the Rip Van Winkle of flotation litigation is disposed of.

Galena to Frame Idaho's Representative Stone

IDAHO has at last fallen into line with her sister states by selecting a representative stone for the Washington Monument in Washington, D. C. To Bunker Hill & Sullivan, one of the state's largest mining organizations, has been given the honor of furnishing the frame of galena ore. Governor H. C. Baldridge is to select the stone, which is being furnished by the Boise Stone Company. Stanly A. Easton, manager of Bunker Hill, has already forwarded the frame to Washington. Stones from all the various states are placed in the winding stairway of the great monument.

Coming to the Metals Recovery *vs.* Anaconda case, an entirely different condition is observed. Instead of requiring about 55 months to reach a decision, the Justice took only two weeks, and then released a document that shows thoughtful consideration.

This case deals with the alleged infringement by Anaconda of the Metals Recovery Perkins patent, commonly known as the non-oleaginous, non-frothing, collecting-agent patent. The plaintiff had claimed that the xanthates and aromatic thio-ureas came within its range.

Justice Bourquin holds that the Perkins patent is too broad and far-reaching in scope to be definitely interpreted; and that the inventor's alleged discoveries were non-patentable because of prior usage of xanthates in the art. The attributes claimed by Perkins for the compounds falling under his patent comprised: (1) an organic compound, (2) solid, (3) non-oleaginous, (4) commonly classed as insoluble, substantially insoluble but soluble to a very small degree, (5) without substantial frothing properties, (6) have mineral collecting properties discoverable and effective when (7) used with not all but some suitable frothing agent (and in addition, in respect to claims 3 and 4), (8) reduced, and (9) relatively easily oxidizable such as, for example, diazoaminobenzene. To quote verbatim from Justice Bourquin's decision: "Defendant's operations are with Xanthate, which as used is neither solid, nor commonly classed as insoluble, substantially insoluble but soluble to a very small degree, nor substantially non-frothing. Lacking three of the seven-nine [sic] attributes of the combination patented, Xanthate is a different compound and not within the patent. To escape this conclusion, plaintiff contends that perhaps the effective principle in Xanthate is Xanthic acid, which is substantially insoluble. If the compound used does not infringe, neither does it for that if resolved into elements some one of them is like to the compound of the patent. In any event, plaintiff's contention aids it none; for Xanthic acid being an oil, did plaintiff avoid the Scylla of solubility, it would fall into the Charybdis of oleaginousness."

In both cases the defense made a "rallying-point" of the argument that the patents were too far-reaching in claims and scope. This condition, it was contended, was sufficient to nullify the patents, and therefore no infringement could exist. This argument was refused in the Magma case, but upheld, after a fashion, in the Metals Recovery *vs.* Anaconda suit.

It is not considered likely that either of the two decisions will be appealed. At least, no word to that effect has been given out.

Nickel and Cobalt Strike Reported from Arizona

A report from Huachuca, Ariz., announces the discovery, 36 miles north of Tucson, of a large deposit of nickel and cobalt. Max R. V. Baumkirchner, general manager of the Arizona Imperial Mines, Inc., expresses the opinion that a large tonnage will average 12 per cent nickel. The outcrop is said to be 4½ miles long and from half a mile to a mile wide. Definite information awaits further investigation.

Lake Superior Institute to Meet in Tri-State

TWENTY-SIXTH annual meeting of the Lake Superior Mining Institute will be held this spring in the Oklahoma-Kansas-Missouri lead and zinc fields instead of on the Menominee iron range in Michigan, as originally planned. This change is agreeable to Institute members on the Menominee range, and it was largely on their recommendation that the change was made. The officers of the Institute hope for the largest attendance of members ever to take one of the organization's annual trips.

Lack of any marked new development on the Menominee range since the last meeting in 1917, familiarity of most of the members with the district, and lack of sufficient hotel accommodations at any one point were contributing factors in the decision to make a trip outside.

The Tri-State district was chosen as the meeting place because of its great importance in the mining industry. It produces 62 per cent of the zinc and 15 per cent of the lead of the United States, and 30 per cent of the zinc of the world. Southeastern Missouri, which will be visited on the return trip, is a factor in the lead production of this country, being exceeded only by the Coeur d'Alene district.

The committee plans to stress the technical side of the meeting and to have two professional sessions, one on geology and one on mining. The meeting will be held under the joint auspices of the Tri-State Zinc and Lead Producers' Association and the Miami section of the A.I.M.E. It is expected that at least 125 members will attend.

Washington Section Commends Senator Oddie

On Feb. 17 the Washington section of the A.I.M.E. passed a resolution commending Senator Tasker L. Oddie of Nevada, chairman of the Senate Committee on Mines and Mining, for his efforts in behalf of the mining industry. In his official capacity, Senator Oddie has been the leader of the fight for increased appropriations.

Large Deposit of Cyanite Reported in Georgia

James H. McCoy, of Asheville, N. C., and Major Higdon, of Franklin, N. C., are reported to have acquired mineral rights to 625 acres of cyanite land in Habersham County, Ga. A large quantity of high-grade cyanite (silicate of aluminum) is on the property, which is located 7 miles from Clarksville, Ga.

Tonopah Gold Production Increases

Recent Find in Forty Mile Canyon Starts a Small Stampede to the Region

JANUARY gold production from the Tonopah (Nev.) district was larger by $5,000 than that for December, and at present there is no indication of any substantial change for February. Total bullion shipped from the two mills in operation was valued at $148,600. Of this total Tonopah Extension Mining shipped $44,600, and Tonopah Mining of Nevada shipped $104,000. The latter company milled 5,310 tons of ore from various sources as follows: From its own mine, 2,229 tons; Tonopah Belmont, 1,463 tons; West End Consolidated, 736 tons; North Star Tunnel, 50 tons; Tonopah Divide Mining, 633 tons; Brougher Divide, 129 tons; and miscellaneous small lots, 70 tons.

As will be noted from the above tonnage record a steady production in the Divide district continues. The 633 tons from the Tonopah Divide mine represents nearly 25 tons a day, all by leasers, of selected ore. Work has been discontinued in the Thomas-Robillard lease block, so that production from the Brougher Divide mine will probably show a further decline for February. Some gold ore of good grade is being mined from the Belcher, and several leasers are active on surface work, prospecting on various properties in the district.

A SMALL STAMPEDE into the Forty Mile Canyon section of Nevada, 40 to 50 miles east of Beatty, Nev., resulted from a rumor that high-grade gold ore had been found there. Most of the population of Beatty moved out temporarily and made locations, and representatives from Tonopah, Goldfield and other Nevada towns arrived as soon as automobiles could transport them there. Some high-grade gold ore was found, but confirmed reports of its quantity are lacking.

Forty Mile Canyon is a very arid, inaccessible, and inhospitable region, and water is scarce—traditional conditions for a Nevada mine.

Leasers at Copper Basin, about 12 miles west of Battle Mountain, Nev., shipped 22 cars of 16 per cent copper ore in January, compared with 16 cars of about the same grade in December. The ore was shipped to the Mason Valley smelter, at Thompson, Nev.

Recent developments at Copper Canyon, several miles west of Copper Basin, are encouraging, and some copper ore is being shipped from this section also. Hauling costs are excessive, however, on account of bad roads and the distance of the haul, so that at present Copper Basin is more favored by leasers.

Work has been resumed at Quartz Mountain, Nev., in the consolidated properties of San Rafael Mining, Calico Mining, and the Quartz Mountain Metals, now known as Quartz Mountain Mines & Milling, after a shutdown of several weeks, previous to reorganization and refinancing.

Toronto Letter

By Our Special Correspondent for Northern Ontario

New Directors Are Elected by Noranda—Toronto Views Rescue Car

TORONTO, FEB. 25, 1928—At a meeting of the directors of Noranda Mines, Ltd., the resignations of T. L. Chadbourne, H. W. Chadbourne, P. A. Rockefeller, and W. D. Baldwin were accepted and the following directors were elected: James Y. Murdoch, president; S. C. Thomson, N. A. Timmins, I. W. Bonbright, F. H. Phippen, and A. L. Ellsworth. Noranda's smelter is handling approximately 500 tons a day, and in January shipped 800 tons of blister copper. The copper carries between $60 and $100 in gold a ton. In March 600 tons a day will probably be treated, and another increase of 100 tons will be made in June. About the middle of summer the 500-ton concentrator plant will be put in operation, and following this the smelter tonnage will be raised to 1,000 tons daily, comprising 700 tons of Horne ore, 100 tons of Horne concentrates, and 200 tons of Waite-Montgomery ore and concentrates. Though the smelter has a rated capacity of 1,000 tons a day, the officials believe they will have no difficulty in treating up to 1,500 tons a day. At the mine the main shaft is now below the 600 level and will be continued to 1,000 ft. Lateral work on the 400 and 500 levels has opened up the "H" orebody. Down to the 300 level this orebody was below commercial grade. On the 400 and 500 levels, however, both copper and gold content are sufficient to justify development.

Argonaut Consolidated Mines, east of the Kirkland Lake district, is negotiating with the Noranda Mines, Ltd., for the treatment of its copper-gold concentrates. At present these concentrates are shipped to New Jersey.

THE mine rescue car of the U. S. Bureau of Mines, in charge of Daniel Harrington, which performed such valuable services at the Hollinger fire, arrived in Toronto on Feb. 16. Through the courtesy of Scott Turner, Director of the Bureau, the car stayed in Toronto a day, to permit inspection by the public. A great deal of interest was shown, and the car was crowded to capacity throughout its stay.

Mr. Ferguson, premier of Ontario, expressed a desire to meet Mr. Harrington and his associates, and a visit was made to the premier's office. Mr. Ferguson showed a keen interest in the work and organization of the Safety Division of the Bureau. He expressed the thanks of the government and the province for the help and co-operation given in the disaster at Timmins. A number of Toronto mining men entertained the members of the party at a luncheon at the National Club.

Sudbury Basin Mines, which owns a large acreage adjoining the Errington mine, in the Sudbury district, has just completed a diamond drill hole which cut 50 ft. of commercial ore, of which 20 ft. is understood to be high grade. The company is capitalized at 300,000 shares; it is proposed to increase this to 2,000,000 shares of no par value. The present shareholders will receive three for one of the old stock and 250,000 shares have also been underwritten at $4 a share. As the company has 200,000 shares of Sherritt-Gordon in the treasury, the financial position will be strong.

Arrangements have been made to finance the Fort Hope Mines, located some distance to the northeast of the Red Lake district. Six hundred thousand shares are being sold at 20c. a share. With this money a shaft will be sunk to a depth of 300 ft. Discovery of Fort Hope was made late last Fall, when only a limited amount of surface work was possible. Assays at the surface, however, were promising, and the property will be thoroughly explored.

THE coroner's inquest into the death of the Hollinger miners, in the recent disaster, has been adjourned until after the investigation to be conducted by Judge Godson. It was considered that this would avoid a good deal of duplication of evidence. Judge Godson has already left for Timmins and will start the investigation on Feb. 28. Hollinger is again operating under practically normal conditions.

High-grading will receive a setback through the sentence just given to W. P. Wilson before the Court of Appeal in Toronto. Last summer Wilson, a farmer living just outside Timmins, was arrested and proved to be one of the big high-grade operators in the district. During the two preceding years he had sold over $135,000 worth of gold to the U. S. Mint. After his arrest $30,000 worth of gold was recovered which had been buried on his farm. He pled guilty, and elected for a summary trial before the judge without a jury. At the trial he was sentenced to a fine of only $1,500. The government, considering this sentence altogether too light in view of the gravity of the offence, and feeling that it would do nothing toward preventing the practice of high-grading, appealed the sentence. The case came up before the Court of Appeal in Toronto on Feb. 24 and Wilson was given an additional sentence of two years in the penitentiary.

At the new O'Brien workings in Cross Lake, good ore is being encountered in the sedimentaries underlying the diabase intrusives. This work is being done in a section of the camp where no discoveries have heretofore been made. A considerable amount of diamond drilling was done and underlying conglomerate was found. It was decided to sink and explore this ground. The Mining Corporation subsequently acquired an acreage and has also sunk to the same point.

London Letter

BY W. A. DOMAN
Special Correspondent

Continued Slump in Tin Price Is Seriously Affecting Some Producers

LONDON, FEB. 14, 1928.—Tin continues to puzzle the market. For some producers the situation is distinctly serious, for the price of the metal has been down to £227 17s. 6d. and is now £231 per ton. Authorities can give no valid reason for the slump, except a threat made some months ago that the price would be forced down to £235. The level suggested has been more than reached, and yet there are at the moment few signs of recovery. I have been told that certain leading metal dealers are buying all that is offered, and are advising their friends accordingly. Their action has instilled fresh courage into the breasts of bull operators, who have been "feeling the draft." All sorts of rumors are in circulation, one being that Henry Ford has decided to scrap his new model car, and consequently will not require such large quantities of tin! Another statement is that American industries have reached their peak, and are slowing down. This does not seem to agree with reports. At the end of January the total visible supplies of metallic tin were 14,851 tons, a drop of 488 tons during the month. At the same time the price fell from £266 to £247 10s. 0d. Producers said to be most seriously affected are the Chinese and the Nigerian companies.

At the meeting of shareholders of Fanti Consolidated last week, Sir Edmund Davis, referring to Rhodesia Broken Hill, said the costs of producing electrolytic zinc will be exceptionally low—in fact "at a price unheard of in the world." Shareholders who have waited so long and patiently for a return on their capital are consequently taking fresh heart.

LESLIE URQUHART, who took over the control of Mount Isa (Queensland) from the Anglo-American Corporation, is now on the property, and has cabled an interesting report upon the position. He says the Queensland government recognizes the magnitude of the undertaking and its economic importance. At a conference with the prime minister, the minister for railways, and the commissioner for railways, an agreement was made with the government regarding railway freights on terms satisfactory to both parties. Mount Isa will now proceed with a program of construction. A plant capable of producing 2,000 tons daily is planned. Supplies of coal and coke have also been arranged for. The question of installing hydro-electric power is also under consideration, and, if satisfactory, Mount Isa will provide the necessary funds for the establishment of the electrolytic refinery in Queensland.

Societies, Addresses, Reports

Echoes of the Institute Meeting

AMONG the important sessions at the Institute meeting (Feb. 20 to 23) in New York were those on Milling Methods and Overproduction, reports of which follow:

Milling Methods

The presence of soluble salts in mill water and their effect on flotation at the Nacozari concentrator, discussed in a paper by C. G. McLachlan, was the opening subject considered at the meeting on Milling Methods on Feb. 20. The research included a study of the origin of such salts, analyses of water, and the effects of the addition of correctives. Its application to practice has been an improvement in the balancing of mill-unit tailing, by by-passing a considerable portion of Dorr thickener overflow water to the tailing pond. The investigation also demonstrated the advantage of adding milk of lime to the mill circuit, instead of feeding dry lime with the ore.

The "Surface Measurement of Quartz Particles," a research by John Gross and S. R. Zimmerley, involved measurement of rate of dissolution of the quartz in hydrofluoric acid. A calibration figure was obtained by coating the quartz particles with silver, as a result of which a relative-surface figure obtained by the dissolution method may be converted into specific surface.

Mr. Taggart, in discussing this paper, criticized the assumption that particle sizes ranged regularly down to the molecular. Experiments at Columbia University indicated that particles of quartz visible under the microscope were all seen readily, but that there was no indication of the existence of the smaller sizes. It was suggested, therefore, that these might be dissolved in the water. It was maintained, moreover, that the reaction product would remain at the surface of the larger particles, thereby inhibiting further action. The effect of such dissolutions on particles of different sizes was not strictly comparable. In conclusion, Mr. Taggart said that the Gross-Zimmerley method would be suitable to demonstrate the Rittinger theory but not the Kick theory. Other speakers complimented the authors on an admirable start. In the paper on "Gas Sorption in Flotation," by A. S. Adams, the author described the results of research on the action of various gases on sulphide minerals, graphite, and sulphur. Although admitting that the results lacked uniformity, he concluded that the floatability of the mineral depends on the nature of the gas used in the bubble. Professor Locke drew attention to the research that had been performed on the action of various gases on sulphide ore. In Australia, for instance, much work was done in a study on the effects of chlorine and carbon dioxide. A. W. Allen maintained that the preference of a substance for a particular gas might be taken to indicate an opportunity for a modification in flotation practice, not only with metallic minerals but also with chemical compounds. If, as seemed evident, the preferential attraction of a mineral for a particular type of gas indicated chemical action, though possibly of feeble intensity, a transition could thereby be traced between this and obvious adsorption effects.

Mr. Taggart criticized the research in that the author had failed to show conclusively a parallelism between the results of the experiments and the plotted Van der Waal equation of state. Work at Columbia University, he explained, had shown that the rate of solubility of gas in the vehicle used was a factor in flotation results. Mr. Taggart objected to the author's statement that flotation minerals are not wetted by water, and inferred that the contamination of an ore with oil underground was responsible for the current impression that flotation could be applied without oil or reagents.

Overproduction

"Problems of Overproduction" was the subject of a special conference held on Tuesday, Feb. 21. That a preponderant proportion of those engaged in mining and mineral industries are facing such problems would appear to be demonstrated by the fact that the main auditorium was filled—a condition that is not usual. C. F. Kelley, president of the Anaconda Copper Mining Company, was to have been the "head-liner" at the meeting, but unfortunately he was prevented from being present. Notwithstanding, the rest of the program, together with the impromptu discussion, furnished some excellent food for thought.

Diagnosis instead of prescription predominated. The trouble is not actual overproduction. Potential overproduction exists in most industries, manufacturing as well as exploitation of raw materials being in the same position. But the real trouble is what may be called for the want of a better term "unintelligent" marketing practices. "Cut-throat" and "ruthless" are the terms applied to the kind of competition that is wiping out the profit of highly efficient production. Although several painted the picture as it is and showed by inference what is needed, only one speaker was intrepid enough to come out frankly and say what appeared to be in the minds of most of the speakers. That individual was Stephen S. Tuthill, secretary of the American Zinc Institute. Mr. Tuthill thinks that the one action that gives hope of practical results within a reasonable period of time is to obtain a modification of the anti-trust and restraint-of-trade laws. The time has come when industry for its own preservation must make a concerted drive in Congress to have these laws changed. The sooner business men realize the necessity for such action, the better, Mr. Tuthill thinks.

E. C. Mahan, president of the National Coal Association, described the condition of the bituminous-coal industry. It has the capacity to produce 900,000,000 tons of coal annually; it can sell half that amount. His proposed program contains two planks: (a) ship no coal on consignment and (b) sell no coal at less than cost. There is no actual overproduction, but the two practices that he would do away with contribute largely to the creation of a buyers' market. Increased utilization is not an effective measure of relief; but consolidation of the producing interests should assist by virtue of the fact that it would make it less difficult in actual practice to carry out the two items mentioned in the proposed program. Government interference, thinks Mr. Mahan, would simply land the industry in the fire; whereas it is now only in the frying pan.

Josiah Keely drew considerable applause by inquiring in a single sentence if the remedy did not "presuppose that some of us should die for the good of the cause."

P. B. Butler, of Joplin, described the zinc situation with particular reference to the Tri-State district. Increased use of zinc will help, but curtailment of production in the Rocky Mountain states as well as in Joplin is the only effective remedy. Here one runs into the anti-trust laws when it comes to concerted action.

Harrington Emerson took a broader view of the situation. He sees vast room for further advance in the efficient functioning of the whole social and industrial fabric. Human effort must be directed in channels other than the production of "surplus" goods. But in order to keep busy we must produce things that now are considered luxuries in such quantity and at such costs that they will become necessaries.

Institute of Metals to Hold Annual Meeting

THE TWENTIETH annual meeting of the Institute of Metals is to be held in London on March 7 and 8. The Institute has a membership closely approaching 2,000. A total of 123 will be admitted to membership this year.

The program calls for a general meeting on the first day, at which the incoming president, Dr. W. Rosenhain, will make an address and a number of papers will be presented and discussed. That evening the annual dinner and dance will be held at the Trocadero Restaurant. On the following day more papers will be discussed and the new offices and library of the Institute will be opened.

Personal Notes

MARK BRADSHAW, mining engineer, has returned to Tonopah, Nev., from New York.

JAMES C. REA has been elected a director of Calumet & Arizona Mining and New Cornelia Copper.

FOREST MATHEZ, a Salt Lake mining engineer, is in California directing the operations of the Mono Mining Company.

JOHN A. BURGESS, mining engineer, has been at Copalitos, Sinaloa, Mexico, making a geological examination of the district.

AMOR F. KEENE, consulting mining engineer of New York City, sailed for London on March 2 on professional business.

R. K. STOCKWELL, British manager of the Robins Conveying Belt Company, sailed for London recently after a trip through the West.

LLOYD C. WHITE, mining engineer of San Francisco, has been at Tybo, Nev., on professional work for the Treadwell Yukon Company.

DONALD KENNEDY has been appointed mine manager of the San Antonio, a property in central Manitoba, in place of A. J. KEAST, resigned.

EDWIN F. ELLIOTT has severed his connections with International Nickel to assume the position of manager in charge of the Callinan Flin Flon Mines.

F. W. CINDEL, long active in Rand mining circles, has retired. He left Johannesburg recently for Cape Town, planning to return to the United States.

FREDERICK G. CLAPP, consulting geologist of New York City, who recently examined properties in Australia, is studying the oil resources of northern Persia.

W. A. MACKAY, of St. Johns, Newfoundland, who for many years has been engaged in the development of Newfoundland's mineral resources, is in New York City.

W. B. DALY, general manager of mines at Butte, Mont., for Anaconda Copper, recently returned to that city after a trip through southwestern United States and Mexico.

O. B. HUNDLEY, for some years assistant reduction superintendent for the Chile Exploration Company, at Chuquicamata, Chile, has returned to the United States. He is staying temporarily in Berkeley, Calif.

THE GENERAL ENGINEERING COMPANY, consulting engineers, announces that it has been engaged to design the concentrator for the Hudson Bay Mining & Smelting Company, Ltd., Manitoba, Canada.

FRANCIS S. SCHIMERKA, formerly research engineer of Arizona Copper, at Morenci, Ariz., is now with Thomas A. Edison in Florida, engaged as chemist in the latter's investigation of rubber-producing plants.

FRED WARTENWEILER has joined the staff of the Johannesburg Consolidated Investment Company, Ltd., as chief metallurgist. Mr. Wartenweiler was formerly associated with Corner House and Rand Mines, Ltd.

GEORGE TEAL, formerly city engineer of Boulder, Colo., and a graduate mining engineer of the University of Freiberg, Germany, has been named city manager of Boulder. Mr. Teal is a native of Colorado.

GEORGE H. CUNNINGHAM, until recently connected with the Electrolytic Zinc Company of Australia, is now associated with American Smelting & Refining. He is making his headquarters at El Paso, Tex.

HANS LUNDBERG, engineer with the Swedish American Prospecting Corporation, lectured recently before the mining and geological students of the Massachusetts Institute of Technology on electrical methods of prespecting.

HON. JOHN BRACKEN, premier of Manitoba, has also been appointed head of the provincial department of mines, recently created as a result of the growing importance of the mining industry in the northern and central parts of the province.

E. H. GUILFORD has been delivering a series of lectures on geophysical prospecting in eastern United States and Canada, which will be concluded on March 7, when he will speak before the Canadian Mining Institute. Mr. Guilford is chief engineer for the Radiore Company.

JOHN B. BUBB has returned from Russia to his home at Berkeley, Calif. Mr. Bubb was constructing consulting engineer for the Soviet government. He aided in the erection of dredges manufactured by the Yuba Manufacturing Company in the Nizny Tagilsky platinum district of Ural.

DR. J. MACKINTOSH BELL, mining geologist, has severed his connections with the Huronian Belt Company, Ltd., and its subsidiary companies, the Keeley Silver mines, Vipond Consolidated, Canadian Lorrain Silver, and Pioneer Syndicate. Dr. Bell was managing director and consulting engineer.

PHILIP O. LONGYEAR, who has been an efficiency engineer for the Miami Copper Company for the last four years, has resigned to accept a position with the Anglo-Chilean Nitrate Company. He and Mrs. Longyear are enjoying a vacation in California, and will leave for Tocopilla, Chile, soon.

JOHN D. GALLOWAY, provincial mineralogist for British Columbia, has left Victoria for Ottawa, where he will confer with the Federal Department of Mines on departmental matters. While in eastern Canada, Mr. Galloway will attend the annual general meeting of the Canadian Institute of Mining and Metallurgy.

DR. HORST SIEG, German organic chemist, recently joined the staff of the department of mining and metallurgical research at the University of Utah. Dr. Sieg's work at the university will be to bridge over the gap between mining and agriculture, and, in particular, to utilize, as byproducts, any substances now discarded by the mining industry.

FRANK HORNE has been engaged by Arthur E. Moysey & Company, mining brokers of Toronto, in an advisory capacity. Mr. Horne has had a wide mining experience, having been for some years associated with several large California mines. He was assistant mill superintendent for the Dome Mines for the last eleven years.

VICTOR A. JAMES, a graduate of Queen's University, who has for several years been with the exploration department of Dome Mines, as consulting engineer, has severed his connection with that company to join the firm of Wright & Boydell as one of the staff of consulting engineers. His office address will be 310-311 McKinnon Building, Toronto.

JAMES OTIS HANDY, director of chemical and metallurgical investigations of the Pittsburgh Testing Laboratory, 72 Washington St., New York City, has returned from Montana and Arizona, where he gave expert evidence on behalf of various copper smelting companies in the litigation over the Carson patents. Mr. Handy will hereafter carry on consulting work in New York and Pittsburgh.

JAMES O'BRIEN, of James O'Brien & Company, mining brokers of Montreal, who has just returned to Canada after spending two years in Siberia investigating mining prospects, is on his way to northern Manitoba, where he expects to spend the next ten months in similar work. The O'Brien interests own a promising mining property lying north of the Flin Flon. Mr. O'Brien, with two engineers, expects to go at least 200 miles further north.

OBITUARY

GEORGE CHALMERS, connected with St. John del Rey Mining for more the 40 years, died recently at the age of 71.

GEORGE TAYLOE MUNFORD, retired mining engineer, died in Washington, D. C., on Feb. 15, in his 72d year.

JAMES WILSON, connected for some time with the mining industry in Utah, died in Portland recently. Mr. Wilson was 75 years old.

JAMES HUBKA, chemical engineer for the American Smelting & Refining Company at Denver, was killed in an automobile accident recently.

Market and Financial News

Some Shrinkage in German Metal Consumption Seems Likely

By Dr. James Rubinfeld
Special Correspondent in Berlin

In spite of the somewhat uncertain character of the economic upswing which has materialized in Germany, and which no economist can satisfactorily explain in view of very heavy debt burdens and adverse trade balances, the metal branch of the economic system continues to appear sound. The prosperity in this field as in many others has its ground in good internal consumption. In my opinion there will be some shrinkage in metal imports into Germany in 1928 compared with 1927. The entries of metallic rawstuffs compare with 1926 according to official statistics as follows:

German Metal Imports

In metric tons except as noted

	1927	1926
Copper	230,844	146,511
Tin	15,765	10,645
Lead	156,866	93,264
Zinc	146,630	100,058
Aluminum	12,794	5,527
Nickel	3,495	1,847
Antimony	3,348	2,279
Platinum (kg.)	6,975	516

Consumption of copper, aluminum, and nickel in raw state exceeds that of former peace times. The internal production of refined copper now reaches at least 55,000 metric tons a year, owing to the activities of the Metallgesellschaft. It should be borne in mind that the quantities of imported semi-finished metallic products were very large in 1927, because of heavy demands of the rollers and other manufacturers. This applies to the whole range of metallic materials. As for platinum, the increased import of which may, of course, appear improbable at first sight, it may be pointed out that the Soviet agency of "Rusplatin" has made a large deposit with the banks with an eye to German credits. The share of Russian platinum in the above import figure is 4,742.5 kg. against none in 1926. The German platinum market has been highly instrumental to the Russians in their policy of weakening their competitors in Transvaal and Colombia.

Another interesting point is the aluminum development here. It seems that the last price reductions of the Aluminum Company of America are greatly barring the way of exports to the United States, as is borne out by the statistics. The price influence has made itself felt only in the final months of the year. Some people apprehend (and others hope) that the American "Trust" may proceed further in cutting prices, so that the European aluminum cartel, which is strongly influenced by Germany, will have to meet the consumers once more. Some aluminum experts even point to the probability of American dumping on European markets when the Arvida and other extensions come into production. I have the impression that all members of the European cartel would hail some understanding with the American "giant," although the hope is already much reduced. Meanwhile aluminum consumption continues to increase apace here, because the so-called "Beratungsstelle," of Berlin, makes one field after another accessible to the light metal.

In general, metal people here are convinced that the thorough and best measure to increase use of copper is to keep it cheap. In view of low production costs for copper of the majority of producers across the Atlantic and of the scarcity of buyers in Germany, a lenient policy on the part of Copper Exporters, Inc., at Brussels, would go far toward insuring a wide and sure outlet for copper in Germany. A too rapid price increase encouraged the spirit of speculation in London and Berlin. When faith of customers in the future price developments is shaken, overbuying takes place, with the result that congestion stands in the way of normal sales. Since Germany possesses a great "staff" of smart jobbers and speculators, the danger of some reaction is always rampant.

It is not improbable that the tremendous depression of the lead markets in the last few years has had its origin in this sort of speculation in Central Europe. The "bear" of the Bourse is a keen student of metallurgical progress, and the steady increase of lead production as a sequel of selective flotation now enters into his reckoning. It is an open secret that "bear" forces are at work anew to press upon lead.

Repeated conferences at Brussels with a view to establishing a European zinc cartel have as yet borne little fruit. I understand that the proposals which are to be laid before the next conference of European producers provide that common restriction of output is to be put in force whenever the London quotation goes under £26 and free stocks in European countries exceed 25,000 tons. Electrolytic material shall be excluded from the pact, but as a rule producers are to be held to demand a premium of around £2 for it over g.o.b. Prices and related factors are to be readjusted every two months in a special conference of delegates.

The vast share of the United States in the world zinc production, along with the Sherman Act forbidding concerted restriction of output over there, appears thus far to frustrate any effective attempts to drive up zinc prices to, say, £30. It is open to doubt whether a free supplying of Russian zinc demands would not more immediately minimize the effects of the increasing world zinc production than any artificial price regulation. An electrolytic refinery is being built by Giesches, as well as another near the Silesian mines (with French capital). Enormous amounts of galena and blende are said to lie upon the dumps of Olkusz and elsewhere in Silesia, awaiting modern treatment. Also in western Silesia, where things seemed most difficult at first, conditions are now much improved, and zinc and lead mining is on the up grade. A blende production of 191,035 tons in 1927 compares with 109,385 tons in 1926. In Polish Upper Silesia the S. A. des Mines et Usines à zinc de Silésie is second to Giesches, and its raw zinc output in 1927 amounted to 31,151 metric tons, against 20,453 tons in 1925. The electrolytic zinc refinery already mentioned will have at the outset a capacity of 8,000 tons a year.

American Metal Company profits for 1927 compare favorably with those of 1926 despite the lower metal prices prevailing. The following figures show the relative comparison:

	1927	1926
Net operating income	$4,822,347	$5,296,102
Depreciation, depletion, exploration, obsolescence	1,674,648	1,694,040
Special provisions	633,935	147,548
Net income	$2,513,764	$2,657,309
Dividends, preferred	350,000	350,000
Dividends, common	1,783,903	2,376,003

Carl M. Loeb, president, says: "Though consumption of metals continued in large volume during 1927, productive capacity has more than kept pace with requirements; and prices of the principal non-ferrous base metals, except copper, declined substantially during the year. Your company has spent and is spending large sums of money in equipment designed to reduce costs of production and to place the company in a favorable position to meet all contingencies of the metal markets. Operations at the Pecos mine, in New Mexico, to which reference was made in the last annual report, have been satisfactory. In accordance with the original plan, the earnings of this property are being and will be applied toward extinguishing the interest and principal of its bonded indebtedness to your company. We continue to invest in and to develop new properties both in this country and abroad. In the nature of the mining industry, the results of such investments take time to materialize."

STATISTICAL NOTES

REPORT of the Ontario Bureau of Mines of gold production of Ontario for 1927 shows a total of $33,409,247, an increase of $2,405,136 compared with the previous year. Of this amount Porcupine produced $23,681,642, a decrease of $129,058. The ore averaged $6.81 a ton, compared with $7.52 in the preceding year. The total tonnage treated was 3,408,251, an increase of 299,308. In the Kirkland Lake camp 793,532 tons was treated, compared with 515,124 tons in the preceding year. Production was $9,727,605, an increase of $2,534,194, and the average grade of the ore was $12.25, a decrease of $1.72. December, however, was the largest month for both camps, the total production of Porcupine being $2,311,082; for Kirkland the production was $1,089,381. During 1928 the production in the Porcupine camp should not be less and will probably be greater than in 1927, as Coniaurum and Paymaster will both be producing. Still further increases are also expected in the Kirkland Lake district.

During 1927 the Argonaut treated 27,873 tons and recovered a total of $157,203, which is an average of $5.68 a ton. Of the total amount $88,890 was recovered by amalgam and $68,313 from the sale of copper-gold concentrates.

SANTA GERTRUDIS COMPANY, LTD., operating in the Pachuca district, in Mexico, has continued operations at the capacity of its plants, despite the continued low price of silver. Improvements in operating practice and a somewhat more favorable attitude on the part of the government toward the taxation problem were reflected in the somewhat higher earnings of the company as compared with the same period in 1926. For the quarter ending Dec. 31, 1927, the mills handled 181,880 tons of ore, giving a net revenue, before making deductions for depletion and depreciation, of $520,093. For the same period in 1926, 186,178 tons of ore was milled, yielding a profit of $384,225 before depreciation and depletion. The average price received for silver sold was $0.5715 per ounce, 999 fine.

N. V. HOLLANDESCHE METALLURGISHEHE BEDRIJVEN has been organized in Holland for the purpose of smelting ores at a smelter to be built in Holland, buying as well as mining ores, and trading in metals. The N. V. Ertsmaatschappij Mineralia at Amsterdam is sole agent for the purchase of ores and sale of metallurgical products.

GOVERNMENT AREAS' recent dividend of 45 per cent, for the last half year, forms a record. The declaration for the two previous half years was 40 per cent, and 32½ per cent was paid for the first half of 1926. The latest declaration will absorb £630,000, bringing the total distribution for the year (1927) up to £1,190,000. In respect to royalties, payable under the lease, an even larger sum than the above will be payable to the Union Government out of the year's gross profits.

NEVADA CONSOLIDATED COPPER COMPANY, operating in Nevada, Arizona, and New Mexico, has just issued its report for the last quarter of 1927. Progressive decreases in the rates of copper production each quarter during 1927 are shown. Average monthly production in pounds is as follows:

First quarter	19,313,598
Second quarter	18,547,099
Third quarter	17,532,023
Fourth quarter	17,501,923

The total quantity of company ores milled and smelted during the last quarter was 2,440,173 tons. Of this total 2,439,718 tons was concentrating ore, averaging 1.27 per cent copper, and 455 tons was direct-smelting ore shipped to smelters. In addition to company ores, 122,046 tons of custom ore was milled or smelted at the Nevada plants. Average daily tonnage of company ores milled at all concentrators was 26,519, compared to 24,674 tons per day for the preceding quarter. The average recovery in the form of concentrates from all company material milled during the period was 86.83 per cent of the total copper contained therein. Net cost per pound of copper produced, after crediting revenue from gold and silver and other miscellaneous earnings and income from subsidiaries, was 9.15c. These costs include all operating and general charges of every kind except depreciation and reserve for federal taxes.

LAKE SHORE MINES, of Kirkland Lake, Ont., made a remarkable record for the three months ended Dec. 31, by the production of $1,035,000 from 58,054 tons of ore, an average recovery of $17.83 a ton. This quarter's production exceeded the best previous quarter by $300,000.

UTAH COPPER COMPANY reports during 1927 an average monthly production of 19,416,889 lb., which compares with 19,514,469 in 1926. During the last quarter of 1927, 3,296,600 tons of ore was milled, as against 3,884,100 in the last quarter of 1926. According to the report just issued for the last quarter of 1927, the average grade of ore treated at the mills was 0.98 per cent copper and the average mill recovery of copper in the form of concentrates was 88.79 per cent of that contained in the ore. The average cost per pound of net copper produced, including depreciation of plant and equipment and all fixed and general expenses, and after crediting gold, silver, and miscellaneous earnings, was 7.4c.

GOLD KING EXTENSION, San Juan County, Colo., has until Feb. 19, 1928, to pay principal and interest on bonds, amounting to $363,600, or suffer foreclosure by the International Trust Company of Denver, trustee for the bondholders, according to a ruling handed down Feb. 9 by Judge James C. Starkweather in the district court of Denver. The property is in the hands of C. N. Kiney, receiver.

TREADWELL YUKON has made first payment of $50,000 on the Tybo mine, 70 miles from Tonopah, Nev., and plans are being drawn up for a flotation plant which is to be placed in operation as soon as possible. The Tybo is the first property this company has acquired in the United States, its other holdings being in the Yukon and in the Sudbury district of Canada.

ENGLISH FERROMANGANESE is to be distributed in the United States, in the future, through two companies—Frank Samuel & Company of Philadelphia, and Rogers Brown and Crocker Brothers, Inc., of New York City.

KIRKLAND LAKE GOLD MINES during 1927 produced $475,000, from which a profit of approximately $100,000 was realized. Net current assets Dec. 31 amounted to $243,000, compared with $148,000 on the corresponding date of the preceding year. Additional equipment has been purchased in order to permit an increase in mill capacity.

MIAMI COPPER, operating in Arizona, has recently been awarded judgment against the Collector of Internal Revenue to the extent of $875,000. This amount represents the settlement of an action brought May 12, 1925, to recover taxes paid under protest for the years 1916-1918 inclusive, on income and profits amounting to $1,118,451 with interest. The compromise was effected with the Washington Tax Bureau.

DOME MINES, operating in the Porcupine district, during 1927 milled 543,300 tons of ore. Total production was $4,031,744, an average of $7.42 a ton. Costs were $2,207,136, or $4.06 a ton, a decrease of 10c. compared with the previous year. Taxes amounted to $75,959 and miscellaneous revenue $211,936, leaving net earnings before depreciation of $1,960,584, an increase of $176,000 compared with 1926.

CALUMET & HECLA CONSOLIDATED for the final quarter of 1927 earned an operating profit of $1,032,099 for the three months, before depreciation and depletion. For depreciation and depletion, $721,272 was charged off, leaving a net profit of $310,517. Copper on hand Jan. 1 was valued at $3,650,171.

GOLD ORE MINES of Idaho has been barred from trading on the Boston curb exchange. Stewart Campbell, state mine inspector, of Boise, Idaho, informed the curb that the company had not complied with the Idaho mining laws. After complete investigation by exchange officials, it was found that advertising material circulated by the concern was misleading.

NIPISSING MINING COMPANY, of Cobalt, for the quarter ending Dec. 31 mined ore of an estimated net value of $312,541 and shipped bullion and residues of an estimated value of $273,742. The low-grade mill treated 17,781 tons and the high-grade plant treated 157 tons, the refinery shipping 454,823 oz. of bullion. On the Montbray property development work at both levels encountered occasional interesting assays in gold and copper, but the exposures were limited in extent.

The Market Report

Lower Prices Stimulate Non-Ferrous Metal Markets

New York, Feb. 29, 1928—From the standpoint of tonnage sold, the week ending today has been the best for a considerable period. However, the business was obtained at the expense of some decline in prices. Copper touched 13.875c. on some sales yesterday, and on Monday 5.40c. was done for zinc. There has been some upward reaction in both metals since then. Lead is now 6c. in New York and can be obtained in St. Louis at 5.75c. Tin has been up and down, with little or no net change, and the same applies to silver at 57.25c. Antimony and platinum are both easier in dull markets.

Daily Prices of Metals

Feb.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
23	13.75@13.775	50.75	51.50	6.20	5.925@5.95	5.40@5.45
24	13 725@13 825	51.00	51.875	6.20	5.95	5.425@5.475
25	13.75@13.85	51.25	52.125	6.20	5.95	5.425@5.45
27	13.75	51.50	52.375	6 15	5.90	5.40@5.475
28	13.65@13.75	50.875	51.625	6.05	5.80	5.45@5.475
29	13.725	50.50	51.375	6.00	5.75	5.45@5.475
	13.752	50.979	51.813	6.133	5.881	5.446

Average prices for calendar week ending February 25, 1928, are: Copper, 13.778; 99 per cent tin, 50.975; Straits, 51.675 N. Y. lead, 6.210; St. Louis lead, 5.963; zinc, 5.448; and silver, 57.250.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for ordinary form of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.13c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Feb.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic	Spot	3M	Spot	3M	Spot	3M
	Spot	3M							
23	61 1/16	60 13/16	66 1/4	227 7/8	230 1/2	20	20 5/16	25	25
24	60 7/8	60 5/8	66 1/4	230 1/8	232 3/4	19 15/16	20 3/8	25	25
27	60 7/8	60 5/8	66 1/4	232 3/4	235 1/2	20 3/16	20 9/16	25 1/8	25 1/8
28	60 13/16	60 9/16	66	231 1/4	233 7/8	19 15/16	20 3/16	25 1/8	25 1/8
29	60 9/16	60 5/16	66	229	231 3/4	19 3/8	20	25 1/8	25

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Feb.	Sterling Exchange "Checks"	Silver		Gold London	Feb.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
23	4.87 1/2	57 3/8	26 1/4	84s11 1/2d	27	4.87 9/16	57 1/4	26 3/16	84s11 1/2d
24	4.87 3/8	57 1/4	26 3/16	84s11 1/2d	28	4.87 7/16	57 1/4	26 1/4	84s10 3/4d
25	4.87 5/16	57 1/8	26 3/16	.....	29	4.87 1/2	57 1/4	26 3/16	84s11d
					Avg.	57.250			

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths of a cent premium.

Average Metal Prices for February, 1928

COPPER:	
New York Electrolytic	13.823
London Standard Spot	61.670
London Electrolytic Spot	66.381
LEAD:	
New York	6.329
St. Louis	6.069
London Spot	20.283
London Forward	20.747
SILVER:	
New York	57.016
London	26.205
Sterling Exchange	487.008
ZINC:	
St. Louis	5.551
London Spot	25.518
London Forward	25.506
TIN:	
99 per cent	51.793
Straits	52.440
London	233.833
QUICKSILVER	121.370
ANTIMONY	10.842
PLATINUM:	
Refined	84.783
Crude	74.783
ALUMINUM, 98 PER CENT	24.300

Better Business in Copper

Not since the week of Dec. 7 have the aggregate sales of copper been as large as in the week ending today. Even at that they are below "normal" volume. The large producers persist courageously, if monotonously, to hold the domestic price on the basis of 14.125c. delivered in Connecticut. This price has been realized on scattering sales, and two good-sized transactions for delivery in the so-called Middle West area brought 14.25c. Custom smelters, however, got to the point where they felt they had to sell; and the 14c. level was cut through to obtain business. Some sales were made as low as 13.875c., but the prevailing figures were 13.925c., 13.95c., and 13.975c. on the Connecticut basis. Apparently this relieved the pressure to a large extent, and the tone of the market is better today. Brass melters and wire-drawers both participated in the buying. Information from sources in close touch with the Copper Institute is to the effect that a large quantity of March metal yet remains to be purchased to meet current requirements. March and April are the delivery months specified for most of the recent sales. The export association still maintains its c.i.f. price at 14.50c., which corresponds approximately with the nominal price of 14.125c. Connecticut. February sales, abroad, are estimated at 25,000 tons, which is a drastic decline from those of January.

Lead at 6c. New York

The American Smelting & Refining Company cut its contract price for New York lead twice during the week ending today. On Feb. 27 a cut of $2 per ton brought the price from 6.25c. to 6.15c.,

and this morning a further reduction of $3 put the price at an even 6c.

This is the first time since July, 1923, that lead has touched 6c. London has been persistently weak, and this has been reflected in the domestic market. The tonnage changing hands was good in the aggregate, though a large proportion of it was sold by "outside" interests, who offered cut prices in anticipation of the reductions that subsequently were made by the smelting company. Armored cable manufacturers have been the principal buyers.

Zinc Decline Stemmed at 5.40c.

Zinc continued unchanged last Thursday, Friday, and Saturday, but on Monday touched 5.40c. At this juncture one or two important sellers withdrew from the market, and some improvement in prices developed yesterday and today, although demand has been quiet. Sales prior to that time were almost up to normal in volume, with galvanizers and brass manufacturers both participating. Metal for forward delivery has commanded a premium of about 5 points all week, and this accounts largely for the range in the accompanying daily quotations.

Little Change in Tin

Speculative buying of tin in London stiffened the price for Straits a few days ago, but the strength was short-lived. A feature is the almost total absence of any supply of tin of 99 per cent grade in the domestic market. As a consequence the quotations for this grade since last Thursday are purely nominal.

Silver Steady

Continued buying by China with limited offerings has been the cause of a steady market during the past week. While India has been a small seller in this market, it is reported that it has been a buyer today at about current rates. The closing tendency is steady.

Mexican Dollars (old Mexican pesos): Feb. 23d, 44c.; 24th, 43⅞c.; 25th, 43¾c.; 27th, 28th and 29th, 43⅞c.

Foreign Exchange

Further advance was made in sterling exchange during the week, being firm at $4.875 on Tuesday. This was reflected in a better tone for all of the gold currencies. Closing cable quotations on Tuesday, Feb. 28, for the principal foreign exchanges aside from sterling were: Francs 3.93½c.; lire, 5.29¼c.; and marks, 23.89c. Canadian dollars are 11/64 per cent discount.

Zinc and Lead Prices Lower

Joplin, Mo., Feb. 25, 1928

Blende	Per Ton
High	$40.05
Premium blende, basis 60 per cent zinc	$35.00@ 37.00
Prime Western, basis 60 per cent zinc	34.00
Slimes and fines, 60 per cent zinc	31.00@ 33.00
Average settling price all zinc	37.82
Galena	
High	86.65
Basis 80 per cent lead	77.50
Average settling price, all lead	84.24

Shipments for the week: Blende, 11,939; lead, 1,792 tons. Value, all ores the week, $602,510.

Shipments for two months: Blende, 83,408; lead, 14,007 tons. Value, all ores two months, $4,310,100.

Producers disposed of 9,190 tons of zinc concentrates today on the market price, lowered $1 per ton on all grades. The shipment was 200 tons less than the production for the week and 6,880 tons less than the production for the two months.

Platteville, Wis., Feb. 25, 1928.

Zinc Blende	Per Ton
Blende, basis 60 per cent	$37.75
Lead Ore	
Lead, basis 80 per cent lead	$77.50

Shipments for the week: Blende, 759 tons; lead, 40 tons. Shipments for the year: Blende, 5,770 tons; lead, 560 tons. Shipments for the week to separating plants, 1,124 tons blende.

Steel Output at Higher Rate

Pittsburgh, Feb. 28, 1928

Steel production was at a slightly heavier rate in February than in January, the two months running perhaps 2 per cent above the same months of 1927. There was the usual sharp seasonal increase over the rate late in the old year.

The showing of the production rate is less prophetic than usual, because buying had been stimulated by price advances, now fully effective in the open market, but not ruling to any large extent on current shipments, which are chiefly at old prices. In bars, shapes, and plates contracts for the quarter were at 1.80c., Pittsburgh, and advances of a dollar a ton were made in January and February, the open market being now quotable at 1.90c., which is intended to be the second-quarter price. Sheets were booked chiefly at 2.75c. for black and 3.60c. for galvanized, but are now holding fairly well at 2.90c. and 3.75c., respectively.

The crucial test of advanced prices in these lines as well as in wire products and strips will come in the second quarter, when large buyers will be called upon to pay the full prices now quoted.

Steel-ingot production is at about 85 per cent of capacity. Operating rates in the finishing departments average less, as there is always an excess of finishing capacity. Last year's average was 75 per cent in ingot production, with the first half much above the second half.

The steel-consuming lines are running much the same as a year ago, excepting the automobile trade, which has been picking up, but not as much as was expected. In fabricated-structural steel lettings, last year made a high record by a small margin, and lettings have been running high in the first two months of this year.

Pig Iron—The Valley market stays dull, and other markets are somewhat less active than a month ago. Prices are steady at a low level. Bessemer, $17.50; basic, $17; foundry, $17.25, f.o.b. Valley furnaces.

Connellsville Coke—Dull and steady. Spot furnace, $2.65@$2.75; heating, $2.30@$2.50; foundry, $3.75@$4.25.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 98 or 99 per cent grades, price of leading interest, 24.30c.; outside market, 23.90@24.30c. London, 98 per cent, quoted at £105@£107 per long ton for domestic consumption. Largely nominal.

ANTIMONY—Per lb., duty paid, spot: Chinese brands, 10¾@10½c., range for week. Market quiet. Cookson's "C" grade, spot, 16⅜c.

Chinese needle, lump, 8c. Standard powdered needle, 200 mesh, 10c. White oxide, Chinese, 99 per cent Sb_2O_3, 15½c. Nominal.

BISMUTH—Per lb., in ton lots, $2.10. Smaller lots $2.25 and up. London 9s.

CADMIUM—Per lb., 60c. London, 2s. for Australian metal.

COBALT—Per lb., f.o.b. Canadian works: Shot, 96@98 per cent, $2.50. Black oxide, 70 per cent, $2.10. London, 10s. for metal; 8s. for black oxide; 8s. 10d. for gray.

[1]GERMANIUM OXIDE—Per gram in 300- to 500-gram lots, $5.

IRIDIUM—Per oz., $325@$350 for 98@99 per cent sponge and powder. Market inactive.

[1]LITHIUM—Per oz., 98@99 per cent grade in 1- to 5-lb. lots, $5.

MAGNESIUM—Per lb., in ton lots: 8-lb. ingots (3x3x16 in.), 98c.; 3-lb. sticks (1⅜x33 in.), $0.95@$1; 10-oz. sticks (1x12 in.), 85@90c. Market quiet. London 3s. 9d.@4s. 3d. for 99 per cent ingots or sticks.

[1]MOLYBDENUM—Per gram, 99 per cent, 4c. (Usually sold as calcium molybdate or ferromolybdenum, which see).

MONEL METAL—Per lb. base price for shot, 32c., f.o.b. Huntington, W. Va.

NICKEL—Per lb., ingot, 35c.; shot, 36c.; electrolytic, 37c. (99.90 per cent grade), for single lots of spot metal. Good demand. London, per long ton, £170@£175 according to quantity. Market fairly active.

OSMIUM—Per oz., $70@$75; London, £15@£18.

PALLADIUM—Per oz., $50@52. Small lots bring up to $56. London £10¼@£12½. Nominal.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $85 until Feb. 29, when the price was reduced to $80. Dealers and refiners quoted the trade for refined metal, per oz., $78@$82, cash before the cut, and still lower quotations are now available. Market much quieter after moderate activity of recent weeks.

[1]Price furnished by Foote Mineral Co., Philadelphia.

London, per oz., £17½@£17¾ for refined; crude and scrap, nominal.

QUICKSILVER — Per 76-lb. flask, $121@$123. Market quiet. San Francisco wires $123.67. London firm at £21¾@£22.

RADIUM — Per mg. radium content, $70.

RHODIUM—Per oz., $65@$70; London, £10@£12. Nominal.

RUTHENIUM — Per oz., $65@$70. Nominal. London, £7@£9.

[1]SELENIUM — Per lb. in ton lots: Black, powdered, amorphous, 99.5 per cent pure, $2.25. London, 7s. 8d.@7s. 9d. @7s. 9d.

TANTALUM — Per gram: Bar and heavy sheet, chemically pure, 20c.; tantalum powder, 12c. Nominal.

TELLURIUM—Per oz., 15@18c.

[1]THALLIUM METAL—Per oz.: Ingot, 99 per cent pure, $1.06 in 25-lb. lots.

TUNGSTEN POWDER — Per lb. contained tungsten, 97 to 98 per cent pure, $0.94@$0.96.

[1]ZIRCONIUM METAL—Per oz., 98 per cent grade, $1.56 in 5- to 10-lb. lots.

Metallic Ores

CHROME ORE—Per long ton, f.o.b. Eastern shipping points, $22.50@$23.50 for 45 to 50 per cent Cr_2O_3 ore. Prices firm.

IRON ORE—Per long ton, lower Lake ports. Lake Superior ores.

Mesabi, non-bessemer, 51½ per cent iron, $4.25. Old Range, $4.40.

Mesabi, bessemer, 51½ per cent iron, $4.40. Old Range bessemer, 51½ per cent, $4.55.

Eastern ores, cents per unit, delivered at furnaces: Foundry and basic, 58 to 63 per cent, 8@8½c.

Foreign ores, f.o.b. cars Atlantic ports, cents per unit:

North African, low-phosphorus, 11 @11½c., nominal.

Spanish foundry or basic, 50@54 per cent, 8½@9c. Nominal.

Swedish foundry or basic, 66@68 per cent, 9@9½c.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn, 35@38c. Caucasian (washed), 53@55 per cent, 38@40c.

Per ton in carload lots:

[1]Chemical grades, powdered, coarse or fine, 82@87 per cent MnO_2, Brazilian and Cuban, $70@$80. Domestic, 70 to 72 per cent, $40@$50.

TANTALUM ORE—Per unit of combined Ta_2O_5 and Cb_2O_5, basis 65 per cent ore, $20.

TITANIUM ORE—Ilmenite, per gross ton, 52 to 60 per cent TiO_2, f.o.b. Atlantic seaboard, $9.50@$11, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7@$8 per gross ton. Rutile, per lb., 93 per cent concentrate, 10c. for 30 ton lots.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Wolframite, $10.25@$10.50, Western scheelite, $10.40@$10.65. Market dull, prices nominal.

ZIRCON ORE—Per net ton containing 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $8 in 30 ton lots.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

[1]AMBLYGONITE—Per ton, f.o.b. mines: 8@9 per cent lithium oxide, $50@$60.

ASBESTOS—Per ton: f.o.b. Quebec mines, tax and bags included, prices quoted by leading interest:

Crude No. 1, $650; crude No. 2, $400 @$500; spinning fibers, $200@$225; magnesia and compressed sheet fibers, $160@$175; shingle stock, $60@$115, various grades; paper stock, $45@$50; cement stock, $25; short fibers, $10@ $20; floats, $15. Market steady, demand fair.

Per ton c.i.f. New York: Rhodesian crude No. 1, $450; No. 2, $350.

BARYTES—Per ton: f.o.b. mines, bags extra:

Georgia: Barytes ore, crude, (per long ton) $7. Washed and water floated to 97 per cent through 300 mesh, $19. Shipments steady; production about 80 per cent of normal.

Missouri: Water ground and floated, bleached, $23; $25 in less than car lots, f.o.b. works. Crude ore, 93 per cent $BaSO_4$, not to exceed 1 per cent iron, $7.50, f.o.b. mines. Market fair.

BAUXITE — Per long ton: No. 1 chemical ore, over 55 per cent Al_2O_3, less than 5 per cent SiO_2, and less than 3 per cent Fe_2O_3, $8, f.o.b. *Georgia* mines. Pulverized and dried, $14; calcined, $18@$20.

Per metric ton, foreign, c.i.f.: Dalmatian, low SiO_2, $5@$6.50; Istrian, $5.50@$7; French, red, $6@$7.50.

BORAX—Per lb.: Carload lots, in bags, crystals, 4c.; granulated or powdered, 3¾c.; f.o.b. plant, Pennsylvania. Keen competition in market.

[1]CELESTITE—Per ton in carload lots: 90 per cent $SrSO_4$, finely powdered, $27.

CHALK—Per ton: Crude in bulk, c.i.f. *New York*, $4.75@$5.

CHINA CLAY (KAOLIN)—Per ton: F.o.b. *Virginia* mines, crude lump, No. 1, $7: crude No. 2, $5.50; washed, $8; powdered and air-floated, $10@$15; ground, $7@$10.

Florida, pressed pottery, bulk, $13.50; ground, No. 1, $20; No. 2, $15. Sprayed mineral flour, No. 1, $20; No. 2, $17. Market slow.

Best grade, domestic, $16@$18, f.o.b. *Delaware* plants in carload lots.

Imported English, f.o.b. American ports: Lump, $13@$21; powdered, $45@$50.

DIATOMITE — Per short ton, f.o.b. plant:

Kiln-fired brick, $65; kiln-fired aggregate, ¼ in., $45; insulating powder, $25; natural aggregate, ¼ in. $20; air-floated powder, $45. Over 85 per cent silica, 98 per cent through 200 mesh, $25@$26, depending on quantity. Market fair.

EMERY — F.o.b. *Pennsylvania* and *New York* in 350-lb. kegs, per lb.: Greek Naxos, 6½c.; Turkish, 6½c.: Khasia, 5½c.; domestic, 3½c. Market good.

FELDSPAR—F.o.b. mine or grinding plant:

North Carolina, per long ton, No. 1 pottery grade, crude, $6@$7.50. Demand fair.

New Hampshire, per ton: Pottery grade, $8. Best quality lump, $9. Market fair.

New York, Per ton: f.o.b. cars, No. 1 crude, $9. Market very quiet.

Tennessee, per ton: No. 1, pottery, 140 mesh, $16; 200 mesh, $18. No. 2, enamel, 140 mesh, $13.75; 200 mesh, $15.50; demand improving at steady prices.

Maine, per ton: Best pottery grade, ground, $19. Market fair.

FLUORSPAR—Per ton: F.o.b. *Kentucky* and *Illinois* mines.

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $14.50@$15. Quiet. Foundry lump, 85-5, $17. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. Acid lump, 98-1, $30 in car lots. Overproduction is assigned as the reason for weakness in prices.

New Mexico: 85-5 gravel, $16.50; 85-5 lump, $16.50; 93-3 lump, $19. Market good.

Foreign spar, duty paid, $15.50@$16, tidewater.

FULLER'S EARTH — Per ton, f.o.b. *Florida:* 16 to 30 mesh, $16.50; 30 to 60 mesh, $18; 60 to 100 mesh, $14; 100 mesh up, $8; 200 mesh up, $14. Market fair at unchanged prices.

Powdered, import duty paid, $24@ $25 per ton.

GARNET — Per ton; domestic, f.o.b. mines, $85. Market easy.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. mines *Colorado:*

Selected grade, $33; seconds (mine run), $25.50.

GRAPHITE—Per lb.: F.o.b. *New York*. Market easy.

Ceylon lump, 8@8½c.; chip, 7@7½c.; dust, 3@5½c.; Madagascar flake, 7@7½c. Market easy.

No. 1 flake, 10c. and up. No. 2 flake, 7c. and up. Foundry facings, 3c. and up. Amorphous and crystalline, fine ground, 3c. and up. Market weak.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND—Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade in carload lots, $25.

[1]Price furnished by Foote Mineral Co., Philadelphia.

GYPSUM—Per ton, f.o.b. mill, depending upon location: Crushed, $2.75@$3; ground, $4@$8; agricultural, $6@$10; calcined, $8@$12.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 2½@4½c.; domestic earth, 2@4½c. Good demand.

KAOLIN—See China Clay.

[1]LEPIDOLITE—Per ton: $20@$30 for ordinary grades. Nominal.

LIMESTONE—Per ton: f.o.b. shipping points, depending on location, either lump or crushed, 75c.@$2.

Agricultural, $1 up to $4 or $5 for crushed or pulverized. Prices depend upon source, purity, and fineness.

MAGNESITE — Per short ton, f.o.b. *California* mines: Grade "A" calcined, 80 per cent through 200 mesh, $40; Grade B, $38; dead burned, $29; crude, $14. F.o.b. Eastern seaboard, calcined, $40. Market slow.

MICA—Per ton, f. o.b. plant:

New Hampshire: Mine run, $320; clean shop scrap, $25; mine scrap, $22.40. White dry ground, 20 mesh, $25; 40 mesh, $40; 60 mesh, $65; 100 mesh, $80; 200 mesh, $100. Market fairly active.

North Carolina: White, ground, 20 mesh, $35; 70 mesh, $100.

Madagascar, amber, dark, free from iron, per lb., f.o.b. *New York*, duty paid: No. A1, $3.50@$4; No. 1, $3; No. 2, $2.50; No. 3, $1.30; No. 4, 70@80c.; No. 5, 45c. Market strong.

[1]MONAZITE—Per ton: (Minimum 6 per cent ThO_2), $130.

OCHER — F.o.b. *Georgia* mines, per ton: $19@$20 in sacks; $21@$22 in barrels; washed and water floated, $18; second grade, 99 per cent through 225 mesh, $18. Market improved.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7; 75 per cent, $6.25; 74@75 per cent, $6; 70 per cent, $4.50; 68 per cent, $4.10; 66 per cent, $4. Prices firm.

Florida, pebble, domestic: 76@77 per cent, $6; 74@75 per cent, $5; 72 per cent, $4; 70 per cent, $3.50. Market fair.

Tennessee, ground, 97 per cent through 200 mesh, 33 per cent P_2O_5, $9.50 per ton. Brown lump for acid manufacture, per gross ton, $6 on 75 per cent basis; $4.50 on 72 per cent basis. Non-acidulated, fine ground, 65 per cent, $8 (per short ton). Market active.

POTASH—The ruling contract prices are as follows:

	Bags	Bulk
Muriate of potash 80 @ 85 per cent, basis 80 per cent....	36.40	34.80
Sulphate of potash 90 @ 95 per cent, basis 90 per cent....	47.30	45.70
Sulphate of potash-magnesia 48 @ 53 per cent, basis 48 per cent	27.25	25.65
Manure salt 30 per cent.....	21.75	18.75
Manure salt 20 per cent.....	15.40	12.40
Kainit 14 @ 16 per cent.....	12.50	9.50
Kainit 12.4 per cent.....	12.00	9.00

Two thousand pounds net weight, c.i.f. Atlantic and Gulf ports. German weights, tares and analyses.

PUMICE STONE—Per lb.: In barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur: C.i.f. United States ports; guaranteed 48 per cent sulphur, furnace size, 2½-in. diameter, 13¼@13¾c. Fines screened through ½-in. mesh somewhat lower. Cinder from ore to remain property of buyers.

[1]QUARTZ ROCK CRYSTALS—Per lb. in ton lots: Colorless, clear but flawed, pieces ¼ to ½ lb. in weight, 40c. For optical purposes, double above prices; larger crystals still higher.

SILICA—Per ton: Water ground and floated, in bags, f.o.b. Illinois: 400 mesh, $31; 350 mesh, $26; 250 mesh, $18. Market quiet. Glass sand, f.o.b. producing plant, 75c.@$5 per ton; molding sand, 65c.@$3.50; blast sand, $1.35 @$3.50.

[1]SPODUMENE — Per ton: $20@$30, depending upon lithium content. Nominal.

SULPHUR—Per ton for domestic market, $18, f.o.b. Texas mines; $22 for export, Atlantic ports. Prices in reality are on a c.i.f. basis, but the average price reduced to an f.a.s. figure is about as given. Good shipment against contracts. Open prices $1 higher than above.

TALC—Per ton, carload lots, f.o.b. works, containers included:

Vermont: 99 per cent through 200 mesh, extra white, $9.50@$10.50; 96½ to 98 per cent through 200 mesh, medium white, $9@$10; packed in 50-lb. paper bags. Most contracts for 1928 have been closed. Market quiet.

New York: Double air-floated, 200 mesh, $13.75; 325 mesh, $14.75. Demand fair.

Georgia: Powdered, gray, $7.50@ $10; yellow, $9@$12; red, $11@$13; roofing, $7.50@$9. Market fair.

New Jersey: Soapstone, ground, $10 @$12; market fair.

TRIPOLI—Per short ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh; rose and cream colored, $14. Double ground through 110 mesh; rose and cream, $17. Air-floated through 200 mesh, rose and cream, $25; mill run, $15. Quiet.

[1]ZIRCON—Per lb., f.o.b. mines in carload lots: 90 per cent, 4½c.

Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c. Small lots slightly higher. Delivered near by. Quiet. London, per long ton, £17¾@£18 for Cornish white.

CALCIUM MOLYBDATE OR MOLYTE — Per lb. of contained Mo, 95c., delivered.

COPPER SULPHATE (Blue Vitriol)—Per lb. in car lots, 5@5.10c., for either large or small crystals.

[1]Price furnished by Foote Mineral Co., Philadelphia.

SODIUM NITRATE—Per 100 lb.; crude, in bags ex vessel, Atlantic ports, $2.30 for spot; future delivery, $2.30.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $17@$20.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6⅝c.; French red seal, in bags, 9⅜c.

Ferro-Alloys

[1]FERROCERIUM—Per lb., $9 in 15-75 lb. lots.

FERROCHROME—Per lb. of contained chromium, 60@70 per cent chromium, 4 to 6 per cent carbon, 10½@11c.

FERROMANGANESE — Per gross ton furnace: Domestic and foreign, 78@82 per cent, $100 for second quarter of 1928. Spiegeleisen, 19@21 per cent, $30@$32 on carload business, f.o.b. furnace. Market stronger.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.05.

FERROPHOSPHORUS—Per ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50; f.o.b. *Alabama* and *Tennessee*.

FERROSILICON—Per gross ton, f.o.b. works, freight allowed on carload lots east of Mississippi River: 50 per cent, $83.50; 75 per cent, $130; 14@17 per cent, $45. Market fairly active.

FERROTITANIUM—Per ton: For 15 to 18 per cent material, $200, f.o.b. Niagara Falls, N. Y.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, 93@94c., f.o.b. works.

FERROVANADIUM—Per lb. of V contained, f.o.b. works, $3.15@$3.65, depending on grade and quantity. Market fair.

Metal Products

ROLLED COPPER—Sheets, 22¾c.; wire, 16@16¼c. per lb., f.o.b. mill.

LEAD SHEETS—Full rolled, 9¼c. per lb.; clipped, 10c.

NICKEL SILVER—29½c. per lb. for 18 per cent nickel Grade A sheets.

YELLOW (MUNTZ) METAL—Dimension sheets, 19¾c. per lb.; rods, 16¾c. per lb.

ZINC SHEETS—10c. per lb., f.o.b. works.

Refractories

CHROME BRICK—Per net ton, f.o.b. shipping point, $45.

FIRECLAY BRICK — Per M.: First quality, $43@$46, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35 @$38.

MAGNESITE BRICK—Per net ton, f.o.b. works: 9-in. straights, $65.

SILICA BRICK—Per M., *Pennsylvania* and *Ohio*, $43; *Alabama*, $51; *Illinois*, $52.

[1]ZIRKITE—Per lb.: Powdered, 80 per cent ZrO_2, 3½c. Brick, straights, 80c.@ $1 each.

Metal Statistics

Monthly Average Prices of Metals

Silver

	New York		London Spot		Sterling Exchange	
	1927	1928	1927	1928	1927	1928
January	55.795	57.135	25.863	26.313	484.775	487.098
February	57.898	57.016	26.854	26.205	484.551	487.008
March	55.506	.....	25.655	.....	484.887	.....
April	56.399	.....	26.136	.....	485.178	.....
May	56.280	.....	26.072	.....	485.288	.....
June	56.769	.....	26.203	.....	485.183	.....
July	56.360	.....	25.983	.....	485.145	.....
August	54.718	.....	25.224	.....	485.546	.....
September	55.445	.....	25.565	.....	485.878	.....
October	56.035	.....	25.776	.....	486.533	.....
November	57.474	.....	26.526	.....	486.956	.....
December	57.957	.....	26.701	.....	487.714	.....
Year	56.370	.....	26.047	.....	485.636	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine.

Copper

	New York Electrolytic		London Spot Standard		London Spot Electrolytic	
	1927	1928	1927	1928	1927	1928
January	12.990	13.854	55.414	61.912	62.375	66.575
February	12.682	13.823	54.438	61.670	61.119	66.381
March	13.079	.....	55.935	.....	62.641	.....
April	12.808	.....	55.056	.....	61.526	.....
May	12.621	.....	54.563	.....	60.881	.....
June	12.370	.....	54.030	.....	59.881	.....
July	12.532	.....	54.551	.....	60.089	.....
August	12.971	.....	55.364	.....	62.227	.....
September	12.940	.....	54.455	.....	61.830	.....
October	12.958	.....	55.119	.....	62.256	.....
November	13.319	.....	58.830	.....	63.761	.....
December	13.774	.....	60.078	.....	66.181	.....
Year	12.920	.....	55.653	.....	62.064	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1927	1928	1927	1928	1927 Spot	1927 3 Mos.	1928 Spot	1928 3 Mos.
January	7.577	6.500	7.392	6.280	27.485	27.786	21.773	22.213
February	7.420	6.329	7.286	6.069	27.344	27.781	20.283	20.747
March	7.577	.....	7.328	.....	27.845	28.302	.....	.....
April	7.126	.....	6.807	.....	26.546	27.053	.....	.....
May	6.616	.....	6.269	.....	25.054	25.526	.....	.....
June	6.414	.....	6.150	.....	24.438	24.750	.....	.....
July	6.344	.....	6.120	.....	23.491	23.932	.....	.....
August	6.681	.....	6.367	.....	23.119	23.540	.....	.....
September	6.297	.....	6.044	.....	21.446	21.994	.....	.....
October	6.250	.....	6.013	.....	20.479	20.946	.....	.....
November	6.259	.....	6.035	.....	20.889	21.318	.....	.....
December	6.504	.....	6.319	.....	22.163	22.441	.....	.....
Year	6.755	.....	6.511	.....	24.192	24.614	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York				London	
	1927	1928	1927	1928	1927	1928
	99%		Straits		Spot	
January	64.785	55.180	66.415	55.650	297.804	253.222
February	66.528	51.793	69.142	52.440	306.125	233.833
March	67.833	.....	69.199	.....	313.315	.....
April	66.069	.....	67.933	.....	302.572	.....
May	63.935	.....	67.510	.....	294.938	.....
June	64.226	.....	67.466	.....	296.006	.....
July	62.625	.....	64.110	.....	288.690	.....
August	63.523	.....	64.431	.....	293.193	.....
September	60.735	.....	61.490	.....	280.432	.....
October	57.560	.....	58.450	.....	264.631	.....
November	57.089	.....	57.641	.....	262.591	.....
December	58.053	.....	58.452	.....	267.138	.....
Year	62.747	.....	64.353	.....	288.953	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1927	1928	1927 Spot	1927 3 Mos.	1928 Spot	1928 3 Mos.
January	6.661	5.643	30.979	30.938	26.125	26.051
February	6.673	5.551	29.931	30.109	25 518	25 506
March	6.692	.....	30.649	30.889	.....	.....
April	6.338	.....	29.579	29.901	.....	.....
May	6.075	.....	29.034	29.131	.....	.....
June	6.213	.....	28.598	28.613	.....	.....
July	6.229	.....	28.280	28.021	.....	.....
August	6.342	.....	28.210	28.068	.....	.....
September	6.212	.....	27.347	27.327	.....	.....
October	5.996	.....	26.899	26.634	.....	.....
November	5.745	.....	26.281	26.006	.....	.....
December	5.722	.....	26.363	26.109	.....	.....
Year	6.242	.....	28.513	28.479	.....	.....

St. Louis quotations, cents per pound. London pounds sterling per long ton.

Antimony, Quicksilver and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) Refined New York		Platinum (c) Crude New York	
	1927	1928	1927	1928	1927	1928	1927	1928
Jan.	13.910	10.863	101.200	123.620	109.520	79.280	99.820	69.280
Feb.	14.509	10.842	101.727	121.370	107.545	84.783	99.295	74.783
March	12.801	.....	110.259	.....	108.000	.....	100.426	.....
April	14.166	.....	123.250	.....	101.885	.....	91.865	.....
May	12.975	.....	123.900	.....	84.680	.....	75.000	.....
June	12.447	.....	118.096	.....	72.000	.....	62.500	.....
July	11.880	.....	119.880	.....	72.000	.....	61.520	.....
Aug.	11.826	.....	119.111	.....	72.000	.....	62.000	.....
Sept.	11.073	.....	119.640	.....	72.000	.....	62.000	.....
Oct.	11.165	.....	126.200	.....	72.000	.....	62.000	.....
Nov.	10.763	.....	127.708	.....	72.000	.....	62.000	.....
Dec.	11.195	.....	126.933	.....	72.000	.....	62.000	.....
Year	12.393	.....	118.159	.....	84.636	.....	75.036	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. Prior to June, 1927, the unit had been the 75-lb. flask. (c) Platinum in dollars per ounce.

Pig Iron, Pittsburgh, and Aluminum 98 Per Cent

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1927	1928	1927	1928	1927	1928	1927	1928
Jan.	21.04	19.26	20.01	18.76	20.26	19.01	26.270	24.300
Feb.	20.76	.....	19.76	.....	20.26	.....	26.000	24.300
March	21.15	.....	20.33	.....	20.26	.....	26.000	.....
April	21.26	.....	20.49	.....	20.26	.....	26.000	.....
May	20.94	.....	19.96	.....	20.26	.....	26.000	.....
June	20.66	.....	19.62	.....	20.11	.....	26.000	.....
July	20.26	.....	19.26	.....	19.76	.....	26.000	.....
Aug.	20.07	.....	19.01	.....	19.40	.....	26.000	.....
Sept.	19.96	.....	19.04	.....	19.46	.....	26.000	.....
Oct.	19.76	.....	18.76	.....	19.26	.....	25.600	.....
Nov.	19.64	.....	18.76	.....	19.23	.....	25.000	.....
Dec.	19.33	.....	18.76	.....	19.01	.....	24.785	.....
Year	20.39	.....	19.46	.....	19.78	.....	25.808	.....

Iron in dollars per long ton. Aluminum in cents per pound, 98 per cent grade.

Monthly Crude Copper Output in Short Tons

Domestic

	1927 Aug.	Sept.	Oct.	Nov.	Dec.	1928 Jan.
Alaska shipments	2,138	1,879	4,747	1,402	1,655	2,034
Butte & Superior	.....	†284	.....	.....	.....	.....
Calumet & Arizona	2,577	1,807	2,157	2,018	2,065	2,066
Magma	1,182	1,196	1,298	1,404	652	1,300
Miami	2,268	2,008	2,245	2,099	2,032	1,963
New Cornelia	3,039	3,137	3,718	3,613	3,607	3,672
Nevada Con.	.....	†26,298	.....	.....	†26,253	.....
Old Dominion	850	931	871	832	801	*996
Phelps Dodge††	7,366	7,779	7,770	7,799	7,757	8,273
United Verde Extension	1,905	1,813	1,933	1,698	1,930	1,633
Utah Copper	.....	†27,786	.....	.....	†27,810	.....
Tennessee Copper	445	412	532	594	617	510

Foreign

Andes Copper Mining Co.	2,367	2,367	2,367	2,367	2,367	.....
Braden	8,995	8,991	9,343	9,354	9,348	.....
Boleo, Mexico	1,067	852	990	990	1,001	1,068
Bwana M'Kubwa	366	336	496	447	494	.....
Chile	9,020	8,934	8,954	8,960	8,972	.....
Furukawa, Japan	1,461	1,549	1,501	1,649	1,563	.....
Granby Cons., Canada	2,261	2,268	2,550	2,208	1,936	2,305
Mount Lyell, Aust.	.....	†1,515	.....	.....	†2,064	.....
Sumitomo, Japan	1,338	760	1,608	1,317	1,412	.....
Union Miniere, Africa	8,008	9,075	10,230	10,890	10,803	10,390

†Three months. *Includes Arizona Commercial
††Moctezuma is included.

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1926 Monthly Production	Daily Rate	1927 Monthly Production	Daily Rate	1928 Monthly Production	Daily Rate
January	71,026	2,291	76,198	2,458	68,728	2,217
February	68,131	2,433	69,202	2,472	.....	.....
March	75,728	2,443	69,314	2,236	.....	.....
April	73,454	2,448	71,122	2,371	.....	.....
May	73,542	2,372	71,613	2,310	.....	.....
June	71,317	2,377	69,539	2,318	.....	.....
July	72,228	2,330	65,545	2,114	.....	.....
August	72,014	2,323	67,248	2,169	.....	.....
September	72,672	2,421	65,936	2,198	.....	.....
October	75,099	2,423	68,595	2,225	.....	.....
November	74,947	2,498	68,080	2,269	.....	.....
December	72,205	2,329	67,377	2,173	.....	.....
Total	872,509	.....	829,878	.....	.....	.....
Monthly average	72,709	.....	69,165	.....	.....	.....
Average of daily rate	.....	2,390	.....	2,274	.....	.....

Mining Stocks—Week Ended February 25, 1928

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	56¼	54¼	54¾	Ja.14, Fe.20 Q	0.75
Arcadian Consol.	Boston	5¼	4½	5½		
Ariz. Com'l	Boston	5¼	4¾	5	Ja. 19, Ja. 31	0.25
Calumet & Hecla	Boston	22¾	21	22	No.30, De.15 Q	0.50
Cerro de Pasco	New York	63½	62¾	63¼	Ja.12, Fe.8 Q	1.00
Chile Copper	New York	39¾	37¾	38½	Ma. 2, Ma. 30Q	0.62
Con. Coppermines	N. Y. Curb			6		
Copper Range	Boston	16½	16	16½	Ap.2, My.2, A	1.00
Crystal Copper	Boston Curb	*70	*58	*60		
East Butte	Boston	1¾	1¾	1¾	Dec. 1919	0.50
Granby Consol.	New York	40½	39½	39¾	Ja.15 Jy. 1 Q	1.00
Greene Cananea	New York	126¾	114	119¾	Nov., 1920	0.50
Howe Sound	New York	45¾	41	44¾	De.31, Ja.16, Q	1.00
Inspiration Consol.	New York	18¼	18	18¼	Ma.17, Ap.4, Q	0.25
Iron Cap	Boston Curb			3¾		
Isle Royale	Boston	13	12¼	13	Fe. 28, Ma. 15	0.50
Kennecott	New York	82½	80½	82	De. 2, Ja 3 Q	1.25
Magma Copper	New York	46¼	45¼	46	Ma.2, Ap.2 Q	1.25
Mason Valley	N. Y. Curb	1¼	1¼	1¼		
Miami Copper	New York	18¾	18	18¾	Fe.1, Fe.15, Q	0.37½
Mohawk	Boston	47¼	46½	47¼	Ja. 28, Ma. 1 Q	1.00
Montana-Idaho	Spokane	*53½	*52	*52		
Mother Lode Coal	New York	3¼	2¾	3½	De.16, De.31	0.25
Nevada Consol.	New York	20¾	19	19¾	De.16, De.31 Q	0.37½
New Cornelia	Boston	27	26	26¾	Fe. 3, Fe. 20 Q	0.50
Noranda	N. Y. Curb	18¾	17½	18½		
North Butte	Boston	1 1/32	1	1 1/32	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*92	*84	*84	Sept. 1926	0.03
Old Dominion	Boston	10	9½	9½	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	122½	117	121½	De.17, Ja.3 Q	1.50
Quincy	Boston	13½	13	13	March, 1920	1.00
St. Mary's Min. Ld.	Boston	26½	25	26	Fe.10, Ma.10	2.00
Seneca Copper	New York	2¼	2	2¼		
Shattuck-Denn	N. Y. Curb	15¼	14	14¾		
Tenn. C. & C.	New York	11	10½	11	Fe.29, Ma.15, Q	0.12½
United Verde Ex.	N. Y. Curb	22	19¾	20	Ja.4, Fe.1 Q	0.50
Utah Copper	New York	142	142	142	De.16, De.31 Q	1.50
Utah Metal & T.	Boston	1¾	1 1/32	1½	Dec., 1917	0.30
Walker Mining	Salt Lake	*98	*75	*98		
NICKEL-COPPER						
Internat. Nickel	New York	84¾	73¾	78	De.16, De.31 Q	0.50
Internat. Nickel pfd.	New York	112¼	112¼	112¼	Fe. 17, Ma. 1 Q	0.62½
LEAD						
Gladstone Mtn.	Spokane	*9½	*8	*9½	June, 1927	0.005
National Lead	New York	129	127½	128¾	Ma.16, Ma 31 Q	1.25
National Lead pfd.	New York	139	139	139	Ap.23, My.1 Q	1.50
St. Joseph Lead	New York	41	40¾	41	Ma.9, Ma.20, QX	0.75
ZINC						
Am. Z. L. & S.	New York	17¾	13½	16½	May, 1917	1.00
Am. Z. L. & S. pfd.	New York	74	64¾	70	Nov., 1920	1.50
Butte C. & Z.	New York	5¼	4½	5½	De. 9, De. 24	0.50
Butte & Superior	New York	10¾	10½	10½	De.16, De.31 Q	0.50
Callahan Zn-Ld.	New York	2½	2	2	Dec., 1920	0.50
Consol. Lead&Zinc'A'	St. Louis	12½	12	12	Ma.15, Ap.1 Q	0.25
Eagle-Picher	Cincinnati	18¼	17¼	18	No.15, De.1 Q	0.40
Eagle-Picher pfd.	Cincinnati	111	111	111	Jn.30, Oc.15 Q	1.50
New Jersey Zn.	N. Y. Curb	191½	188	191½	Ja. 20, Fe. 10	2.00
Treadwell-Yukon	Toronto	28	26½	27		
United Zinc	N. Y. Curb			25		
Yellow Pine	Los Angeles	*35	*35	*35	Dec. 1925 Q	0.04
GOLD						
Alaska Juneau	New York	3¾	3¾	3¾		
Argonaut	Toronto	*24¼	*20	*20½		
Barry-Hollinger	Toronto	*82½	*75	*79		
Central Manitoba	Toronto	1.57	1.40	1.41		
Con. W. Dome L. new	Toronto	*14¾	*13	*13		
Cresson Consol. G.	N. Y. Curb	2 1/32	2¼	2 1/32	Ma.31, Ap.10 Q	0.10
Dome Mines	New York	12	11¾	11¾	Ma. 31, Ap. 20Q	0.25
Golden Cycle	Colo.Springs	†1.84	†1.81½		Fe.29, Ma.10 Q	0.04
Gold Hill	Toronto	*25½	*21	*23		
Hollinger Consol.	Toronto	17.15	17.00	17.05	Ja.1, Ja.27 M	0.10
Homestake Mining	New York	69¼	69¼	69¼	Fe.20, Fe.25 MX	1.50
Kirkland Lake	Toronto	1.89	1.50	1.57		
Lake Shore	Toronto	23.00	21.50	21.55	Ma.1, Ma.15 QX	0.20
McIntyre-Porcupine	New York	27	26¾	26¾	Fe. 1, Ma. 1 Q	0.25
Portland	Colo.Springs	†*30	†*26½		Ap.6, Ap.15, Q	0.02
Rand Mines	New York	40¾	40½	40½	Au.22-29 Am.Sh.	1.52
Sylvanite	Toronto	3.30	3.25	3.25		
Teck-Hughes	Toronto	8.70	8.25	8.25	Fe.1, X	0.15
Tom Reed	Los Angeles	*33½	*30	*30	Dec., 1926	0.02
Tough-Oakes	Toronto	*62½	*54	*57½		
United Eastern	N. Y. Curb	*67	*65	*67	July, 1924	0.05
Vipond Cons.	Toronto	*56	*46	*54	Apr.1, Apr.15	0.03
Wright-Hargreaves	Toronto	4.60	4.05	4.54	Ja. 17, Fe. 1	0.05
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	24¾	22½	24		
Con. Cortez	N. Y. Curb			*19		
Dolores Esperanza	N. Y. Curb	*50	*43	*43	July, 1923	0.05
N.Y. Hond's Rosario	N. Y. Curb					
Premier Gold	N. Y. Curb	2¼	2¼	2¼	De.15 Ja. 4	0.08
Tonopah Belmont	N. Y. Curb			1¾	Ma.15, Ap.4	0.08
Tonopah Extension	N. Y. Curb	*11	*10	*11	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	4¼	4¼	4¼	Se.20, Oc.21	0.07½
West End Consol.	N. Y. Curb			*5	Mar., 1923	0.05
Yukon Gold	Boston Curb			*70	June, 1918	0.02
SILVER						
Beaver Consol.	Toronto	1.44	1.24	1.29	May, 1920	0.03
Castle-Trethewey	Toronto	*69	*63	*66		
Coniagas	Toronto	4.90	4.70	4.90	May, 1924	0.12½
Keeley	Toronto	*61	*55	*55	Ma. 1, Ma. 15	0.04
Lorrain Trout Lake	Toronto			*60	July, 1925	0.05
Mining Corp. Can.	Toronto	3.83	3.55	3.70	Ja.10, Ja.25	0.15
Nipissing	N. Y. Curb	5	4¾	4¾	De. 31, Ja.20 Q	0.07½

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	3¼	2¾	3	Ma. 25, Ap.4, QX	0.12½
Bingham Mines	Boston	53¾	53¼	53¾	Ja. 21, Fe. 1 Q	0.95
Bunker Hill&Sullivan	N. Y. Curb	153¾	145	145½	Ja.31, Fe 4 NX	0.75
Cardiff M. & M.	Salt Lake			*62	F b 5, 1927	0.10
Chief Consol.	Salt Lake	4.77	4.40	4.50	Ja.10, Fe.1 Q	0.10
Consti'nMng.&Mill'g	Spokane	*20	*15	*18		
Erupcion	Boston Curb	*40	*25	*40	De 17, Ja.3 Q	0.07½
Eureka Lily	Salt Lake	2.55	2.25	2.40		
Federal M. & S.	New York			140	Jn.25, Jn.29 Spec.	$10
Federal M. & S. pfd.	New York			95	Fe 24 Ma.15 Q	1.75
Hecla Mining	N. Y. Curb	17¼	16	17¼	Fe.15, Ma.15 Q	0.25
'Highland-Surprise	Spokane	*15	*14	*14		
Iron King Mining	Salt Lake	*67	*64	*64		
Keystone Mining	Salt Lake	*27	*27	*27	Au. 12, Au. 26	0.07½
Lucky Jim	Spokane	*42½	*40	*40		
Lucky Tiger-Com.	Kansas City	†8.00	†7.85		Fe.10, Fe. 20	0.07
Mammoth Mining	Salt Lake	2.10	2.00	2.00	Jn.10, Jn.20 Q	0.05
North Lily	Salt Lake	5.90	5.70	5.90		
Park Utah	New York	11½	10	11	De. 15, Ja. 3 Q	0.20
Plutus Mining	Salt Lake	2.65	2.00	2.65	Oc. 25, No. 10 Q	0.10
Silver King Coal.	Salt Lake	11.00	10.87½	10.87½	De. 24, Ja.2 X	0.35
Silversmith	Spokane	*26	*21	*24½	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*48	*46	*46		
Sunshine M. Co.	Spokane	1.35	1.00	1.35		
Tamarack-Custer	Spokane	1.26	1.13	1.13	Sept., 1924	0.25
Tintic Standard	Salt Lake	15	14	14¾	De.20, Ja.3 QX	0.40
Utah-Apex	Boston	4¼	4¼	4¼	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	57¾	55¼	57	Se. 2, Oc.1	1.75
Cleveland-Cliffs Iron	Cleveland	120	107	108	Ja.13, Ja.25 Q	1.00
Colorado Fuel & Iron	New York	73½	68	70½	May, 1921	0.75
Gt. North'n Iron Ore	New York	22¾	21¾	22	Dec. 6, Dec. 28	0.75
Inland Steel	New York	49¼	48	48¾	Fe 15 Ma.1 QX	0.66¾
Replogle Steel	New York			12½		
Republic I. & S.	New York	61¼	58¾	61	Fe. 15, Ma.1 Q	1.00
Republic I. & S. pfd.	New York	107½	107½	107½	Ma. 15, Ap. 2 Q	1.75
Sloss-Sheffield S. & I.	New York	124	122	124	De. 10, De. 20 Q	1.50
Sloss-Shef. S.&I. pfd.	New York			119	De. 20, Ja.3 Q	1.75
U. S. Steel	New York	141¾	138¾	140	No. 30, De. 30 Q	1.75
U. S. Steel, pfd.	New York	139¾	139	139	Oc.30, No. 29 Q	1.75
Virginia I. C. & C.	New York			34	Jan., 1924	1.50
Virginia I.C.&C. pfd.	New York			60	De. 16, Ja. 3	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol.	New York			24	Jn. 26, Jn.30	1.45
So. Am. G. & P. New.	N. Y. Curb	3	2¾	2¾		
Alum. Co. of Amer.	N. Y. Curb	127	124¾	127		
Alum. Co. of Amer. pf.	N. Y. Curb	106¾	106¼	106¾	De. 15, Ja1 Q	1.50
Vanadium Corp.	New York	83	77¼	79¼	Fe. 1, Fe. 15 Q	0.75
Patino M. & E.	New York	25¼	24¼	24¾	De 31, Ja. 14	4s.
ASBESTOS						
Asbestos Corp.	Montreal	33	31¼	32½	Jan., 1926	1.50
Asbestos Corp. pfd.	Montreal	93	92¼	93	De.31, Ja.16 Q	1.75
SULPHUR						
Freeport Texas	New York	72¼	65¾	70½	Ja.14, Fe.1 QX	1.75
Texas Gulf	New York	72¼	69½	70¼	Ma.1, Ma.15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	40¾	40	40¾	Fe.18, Ma.1 Q	0.75
Amer. Metal, pfd.	New York	117¾	117½	117½	Fe.18, Ma.1 Q	1.75
Amer. Sm. & Ref.	New York	173½	169¼	171	De.31, Fe. 1 Q	2.00
Amer. Sm. & Ref. pfd.	New York	133½	133¼	133½	De.31, Ma.1 Q	1.75
Consol. M. & S.	Montreal	273	265	267	De. 31, Ja. 16 X	6.25
Newmont Mining	N. Y. Curb	163½	147	160	Ja 3, Ja. 17	1.00
U. S. Sm. R. & M.	New York	40¾	39½	40½	Ja. 6, Ja. 14 Q	0.87½
U.S. Sm. R.&M. pfd.	New York	53	52½	52¾	Ja. 6, J3 14 Q	0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED FEBRUARY 14, 1928

Name	High	Low	Last	Date	Amount	Last Div.
Aramayo Mines (25 frs.)	68/9	65/—	66/3	Feb., 1928	5	p.c. (†)
British Platinum (£1)	—/3	—/1½	—/3	Feb., 1925	2½	p.c.
Burma Corpn. (10 rupees)	13/4½	12/10½	13/3	Jan., 1928	6	annas*
Bwana M'Kubwa (5s)	4/9	4/—	4/4½			
Camp Bird (2s)	3/9	3/1½	3/3			
El Oro (£1)	4/1½	3/3	4/—	Nov., 1924	2½	p.c.*
Esperanza (10s)	—/1	—/1	—/1			
Frontino & Bolivia (£1)	14/3	13/9	13/9	Jan., 1928	5	p.c
Mexican Corpn. (£1)	8/—	7/—	8/—			
Mexico Mines of El Oro (£1)	25/7½	22/6	22/6	Dec., 1926	3¾	p.c *
N'Changa Copper Mining	10/7½	9/9	10/—			
Oroville Dredging (£1)	4/3	3/10½	4/3	Dec., 1923	3¾	p.c.
Ouro Preto (£1)	2/6	2/3	2/6	May, 1925	2½	p.c.
Rhodesian Congo Border (£1)	22/6	16/3	20/—			
St. John del Rev (£1)	10/6	9/9	10 6	May, 1927	3¾	p.c
San Francisco Mines (10s)	27/3	26/1½	26/6	Jan.	1928	25s.
Santa Gertrudis (£1)	15/3	14/7½	15/—	Jan.,	1928	7½ p.c
Selukwe (2s. 6d.)	7/1½	6/3	6/3	April,	1917	6¾ p.c
S. Amer. Copper (2s.)	1/—	—/1½	—/10½	Nov.,	1917	75 p.c
Tanganyika (£1)	69/10½	61/10½	63 9	Aug.,	1927	7½ p.c
Union Miniere du Haut-Katanga (Brussels)	11.900	11 000	11.050	July,	1927	182.60 (‡)

* Free of British income tax. † Swiss francs and plus 15 p. c. bonus. ‡ Belgian frs. and free of taxation.